Municipal and County Engineering

DESIGN, CONSTRUCTION, OPERATION AND MAINTENANCE OF ALL PUBLIC WORKS

Vol. LVIII. JUNE, 1920. No. 6.

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MUNICIPAL AND COUNTY ENGINEERING is published monthly by Engineering Publishing Company, 702 Wulsin Building, INDIANAPOLIS, INDIANA, A. P. Fox, President; J. H. Pritchard, Secretary.

Editorial and Advertising Offices, 538 S. Clark Street, CHICAGO, ILLINOIS. Samuel C. Hadden, Editor and General Manager.

Single copies, 25 cents. The yearly subscription price in the United States and its Possessions, Cuba and Mexico, is $2.00; in Canada, $2.40; and in all other countries, $2.75.

Entered as second-class matter July 1, 1899, at the Post Office at Indianapolis, Indiana, under the Act of March 3, 1879.

Changes of address, subscriptions and remittances should be addressed to MUNICIPAL AND COUNTY ENGINEERING, Indianapolis, Indiana. Editorial and business communications should be addressed to 538 S. Clark St., Chicago, Illinois.

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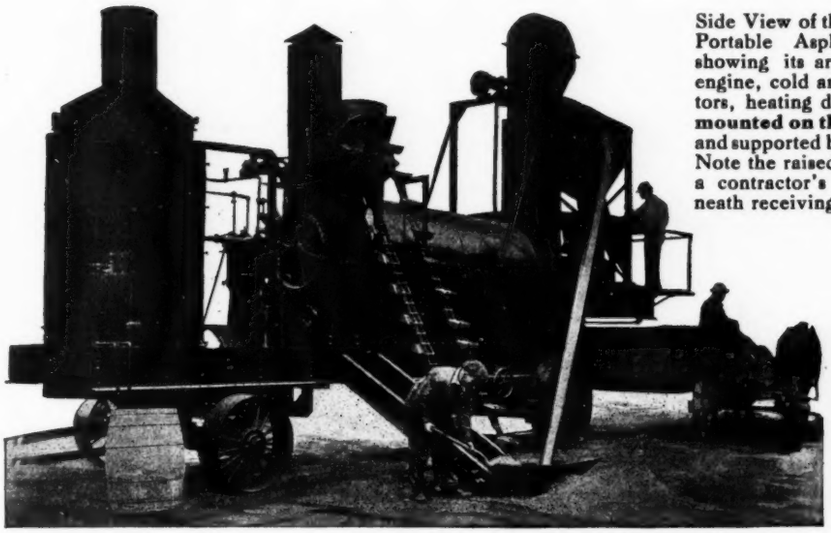

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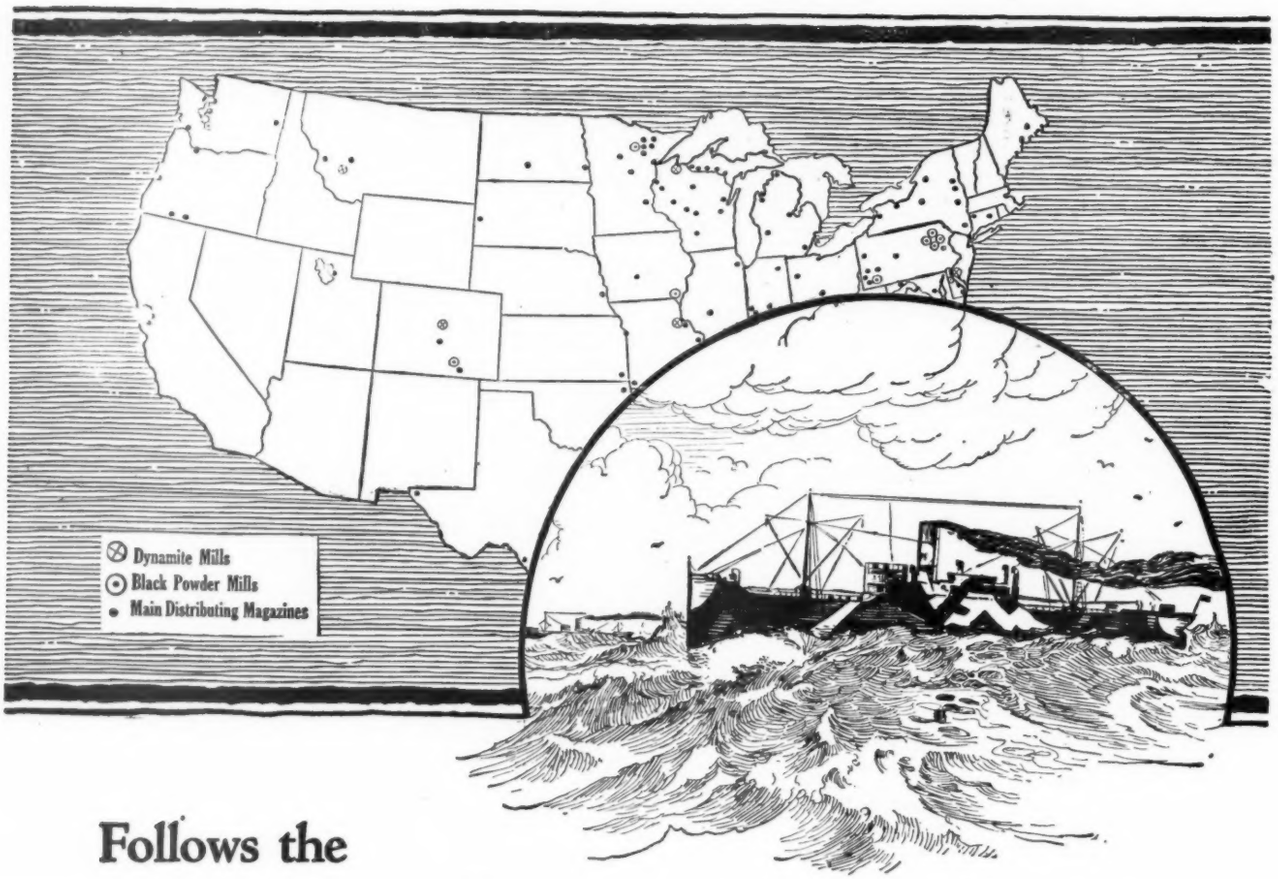

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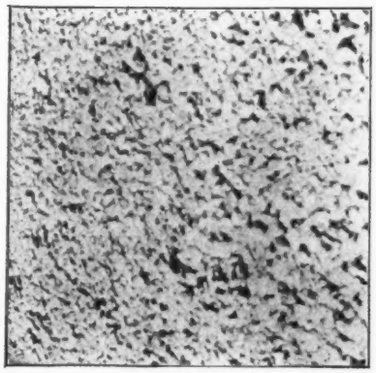
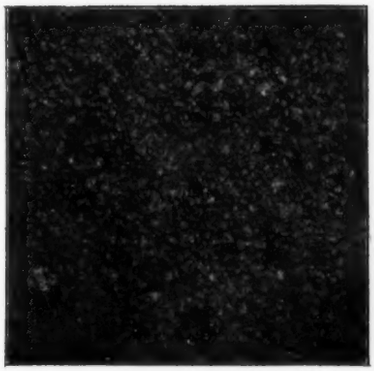


LOAD

THE FOUNDATION

may be of Telford, broken stone or gravel. It should be compact and solid. The chief function of the foundation is to distribute the *load* of traffic.



WEAR

Wearing Surface with first coat of TEXACO Asphaltic Cement and broken stone.

Wearing Surface with final seal coat of TEXACO Asphaltic Cement.

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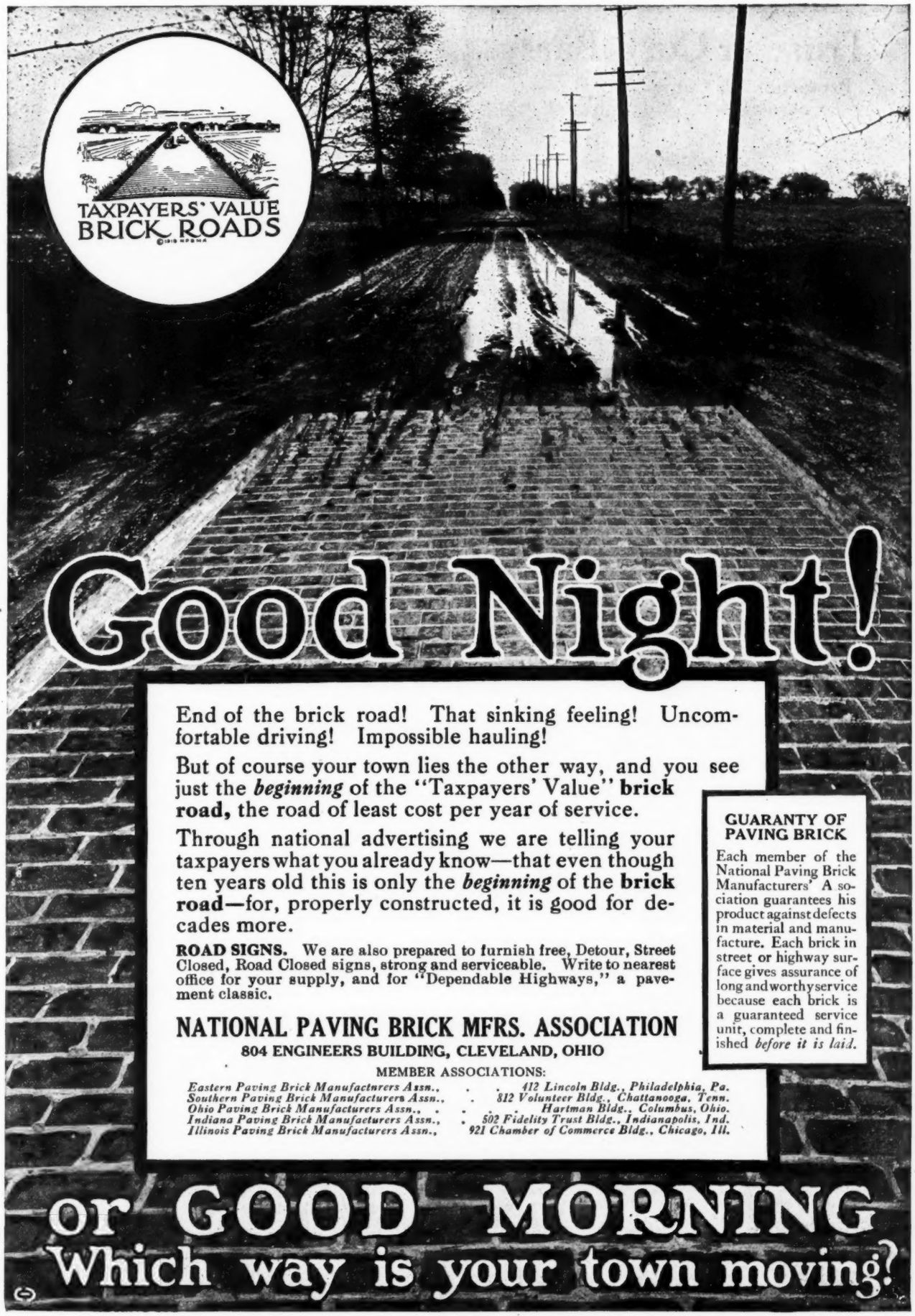

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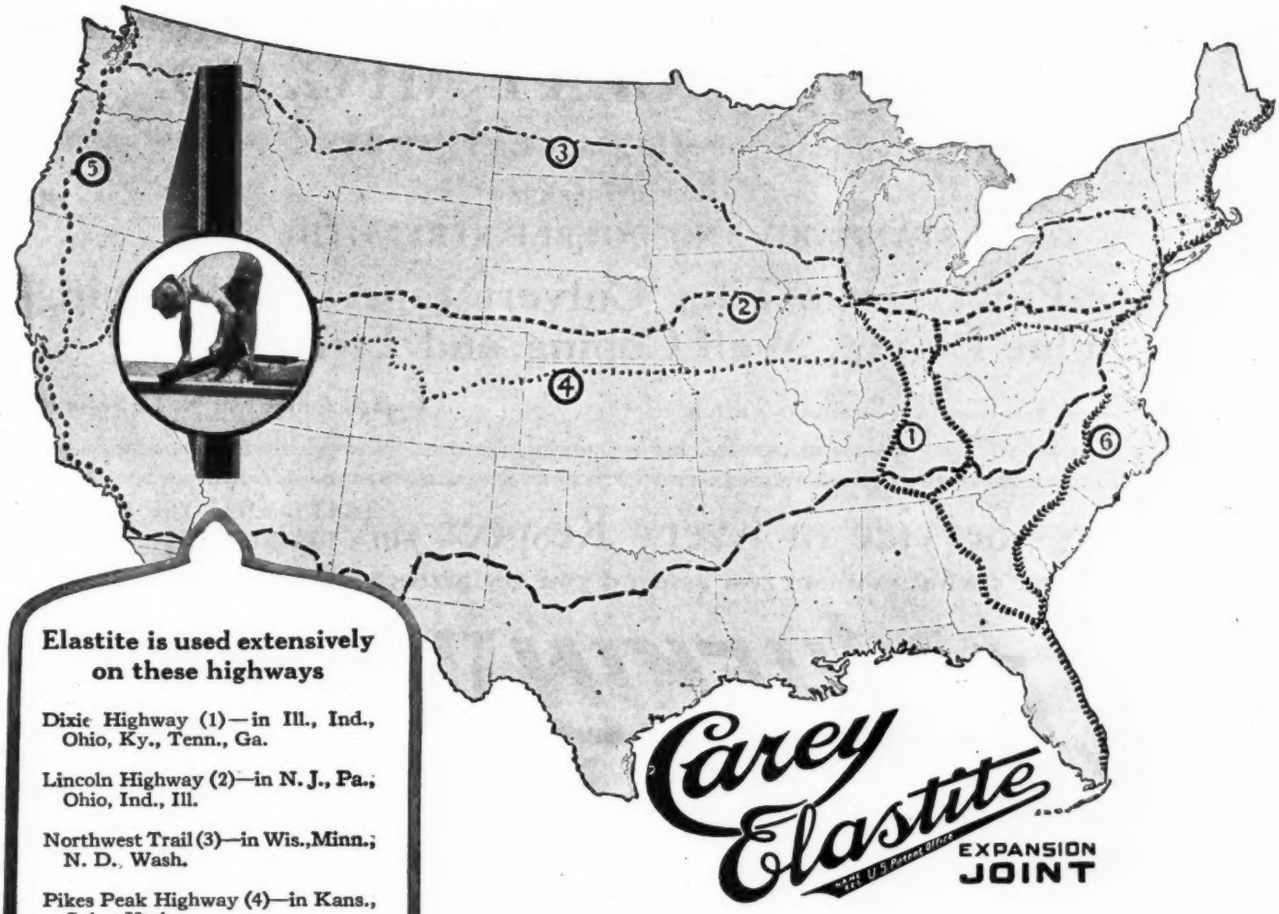

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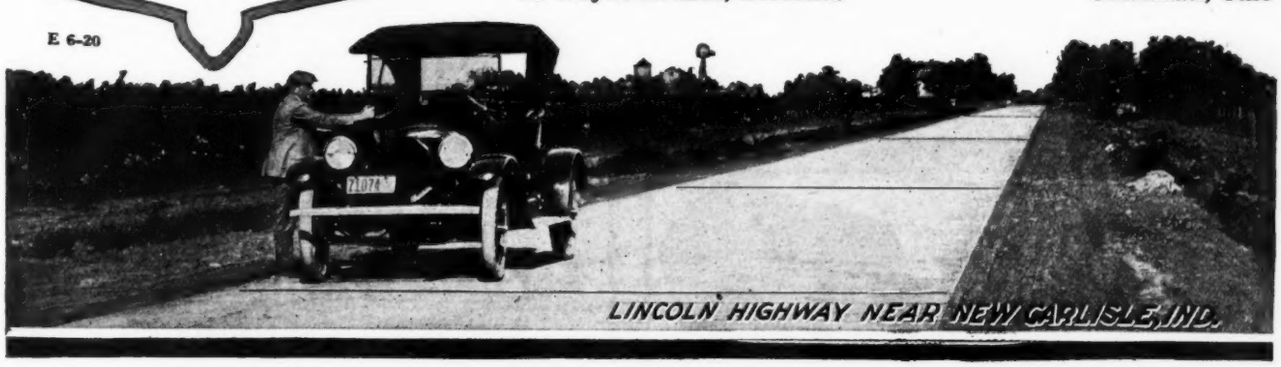

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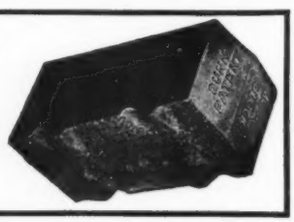

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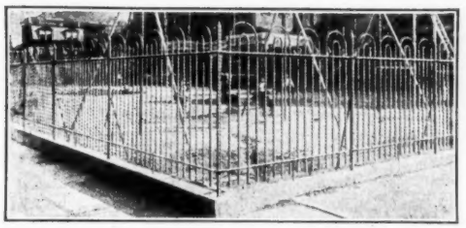

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Dee Clay Mfg. Co., W. E.

Dryers.
Cummer & Son Co., The F. D.

Dump Cars.
Austin-Western Road Machinery Co., The

Dump Wagons.
Austin-Western Road Machinery Co., The

Dust Laying Compound.
Barber Asphalt Paving Co.
The Barrett Co.
Sinclair Refining Co.
Standard Oil Co. (Indiana)
The Texas Co.

Edge Protector.
Truscon Steel Co.

Elastite.
Philip Carey Co., The.

Electrical Wires & Cables.
American Steel & Wire Company

Elevating Graders.
Austin-Western Road Machinery Co.

Elevators.
C. H. & E. Mfg. Co.

Engineering Instruments.
Kolesch & Co.
Lufkin Rule Co,, The

Engines.
C. H. & E. Mfg. Co.

Excavating Machinery.
F. C. Austin Machinery Co.
Pawling and Harnischfeger.
Sauerman Bros.
Smith Co., T. L. The.

Expansion Joint Compound.
The Barrett Co.
Philip Carey Co., The.
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Truscon Steel Co.

Explosives.
E. I. du Pont de Nemours & Co.

Fence, Iron.
Cincinnati Iron Fence Co.

Fillers (Paving Joint).
Barber Asphalt Paving Co.
The Barrett Co.
Philip Carey Co., The.
Pioneer Asphalt Co.
Sinclair Refining Co.
The Texas Co.

Fire Brick.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Flue Liners.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Forms, Sidewalks, Curb & Gutter.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Forms, Road.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Forms (Sewers & Conduits).
Heltzel Steel Form & Iron Co.

Forms (Wall Bldg., Construction, Etc.).
Heltzel Steel Form & Iron Co.

Gas Pipe.
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Cast Iron Pipe Publicity Bureau
Crane Co.
U. S. Cast Iron Pipe & Fdy. Co.

Graders.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Gravel Screener and Loader.
The Jordan & Steele Mfg. Co. Inc.
Good Roads Machinery Co., Inc.

Heaters (Rock and Sand).
Littleford Bros.

Heating Wagons (Oil and Tar).
Good Roads Machinery Co., Inc.
Littleford Bros.

Hoists (Concrete, Gasoline and Hand).
Pawling and Harnischfeger

Hoists, Electric.
Pawling and Harnischfeger.

Hoists—Motor Truck.
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Lewis-Hall Iron Works.

Hot Mixers.
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Barber Asphalt Paving Co.

Hydrants.
Flower Valve Mfg. Co.

Inlets (Sewer).
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Madison Foundry Co.

Insulating Material.
The Barrett Co.
Pioneer Asphalt Co.

Iron Fence.
Cincinnati Iron Fence Co.

Joint Fillers (Paving).
The Barrett Co.
Philip Carey Co., The.

Kettles (Portable).
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Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.

Manhole Covers.
Madison Foundry Co.
Dee Co., Wm. E.

Mastic.
Pioneer Asphalt Co.

Meter Boxes.
McNutt Meter Box Co.

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It is natural to look for high quality and liberal and truly helpful service where the greatest facilities exist.

In the paving brick field that means: "Look to METROPOLITAN, the Largest Maker of Paving Brick in the World."

Here you will not look in vain. The operation of seven modern brick plants, and a staff composed from top to bottom of highly experienced brick men is surely a guaranty that we *can* serve; and our record plus the reputation of *"Bessemer"* and *"Metropolitan"* brand paving brick is a guaranty that we *will* serve. May we serve *you?*

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CANTON, OHIO

LARGEST MAKERS OF PAVING BRICK IN THE WORLD.

TAXPAYERS' VALUE
BRICK ROADS

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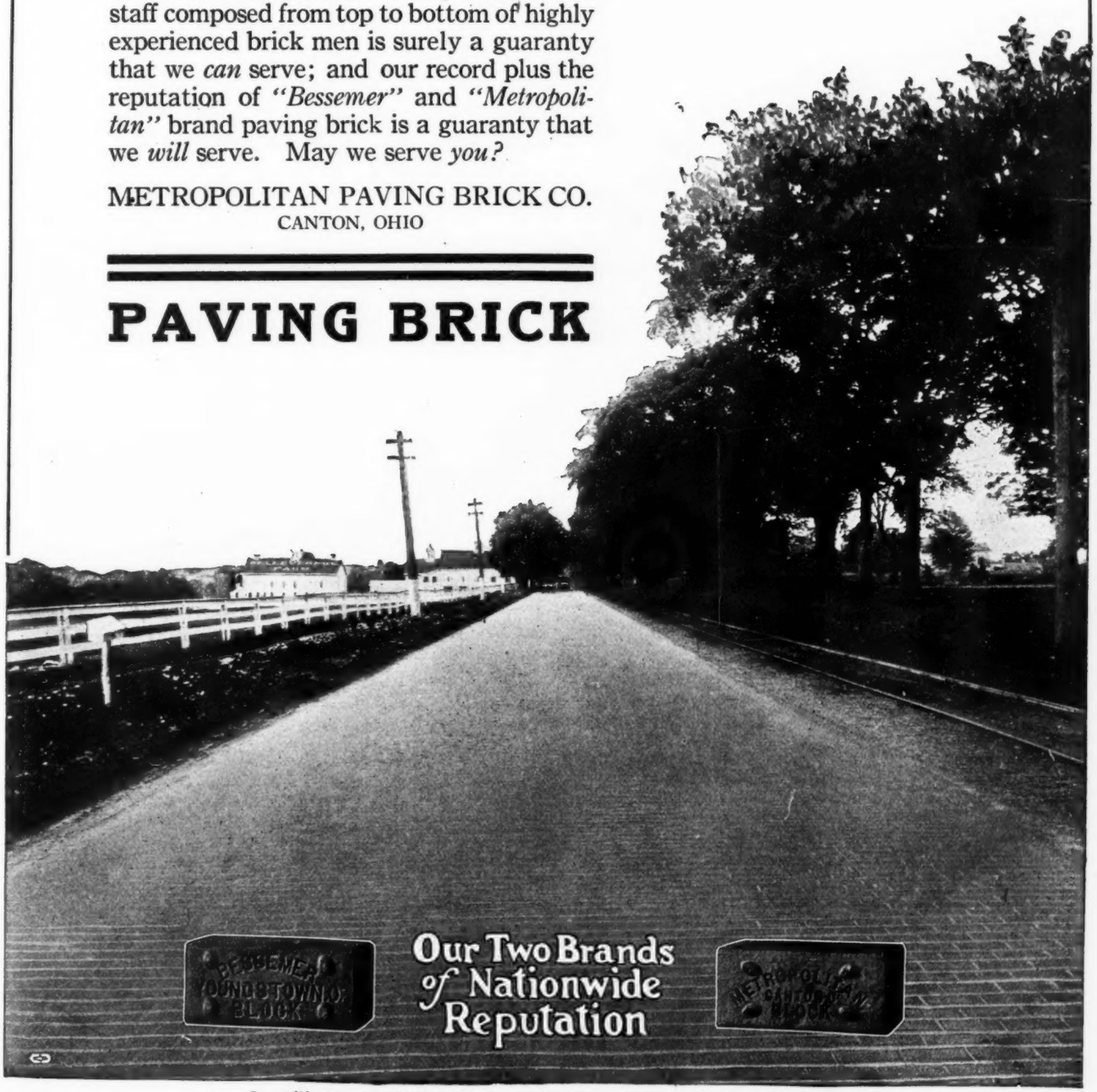

BUYERS' GUIDE

Mixers, Asphalt.
Austin Machinery Corporation.
Barber Asphalt Paving Co.
Cummer & Sons Co., The F. D.

Mixers, Concrete.
Austin Machinery Corporation.
Koehring Machine Company.
T. L. Smith Co.

Mixers—Mortar.
C. H. & E. Mfg. Co.

Molds (Pipe & Culvert).
Heltzel Steel Form & Iron Co.

Motor Fire Apparatus.
Acme Motor Truck Co.
Diamond T Motor Car Co.
Duplex Truck Co.
Federal Motor Truck Co.
Garford Motor Truck Co.
The Gramm-Bernstein Motor Truck Co.
Kissel Motor Car Co.
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Packard Motor Car Co.
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The Texas Co.

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Warren Bros. Co.

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Austin-Western Road Cach. Co.

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Harris Air Pump Company.
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Truscon Steel Co.

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Barber Asphalt Paving Co.
Kentucky Rock Asphalt Co.
Sinclair Refining Company.
The Texas Co

Road Binder.
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The Barrett Co.
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Pawling and Harnischfeger.
Sauerman Bros.

Scrapers, Graders, Plows, Etc.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Scrapers, Power.
Sauerman Bros.

Sewage Treatment.
Direct Oxidation Process Corp.
Electrolytic Sanitation Co.

Sewer Braces.
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Madison Foundry Co.

Sewer Cleaning Machinery.
Stewart, W. H.

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Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.
Clay Products Association.

Sewer Rods.
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Sidewalks (Stone).
Cleveland Stone Co.

Sluice Gates.
Coldwell-Wilcox Co.

Snow Removal Machinery.
Austin Machinery Corporation.
Good Roads Machinery Co., Inc.

Special Castings.
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U. S. Cast Iron Pipe & Fdy. Co.

Sprinklers.
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Austin-Western Road Machinery Co., The

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Truscon Steel Co.

Steel Tapes.
Kolesch & Co.
Lufkin Rule Co., The

Stone Crushers.
Austin-Western Road Machinery Co.

Stone Curbing.
Cleveland Stone Co.

Stone Elevators.
Austin-Western Road Machinery Co.

Stone Flagging.
Cleveland Stone Co.

Stone Spreaders.
Austin-Western Road Machinery Co.
Burch Plow Works Co.

Stone Screens.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Street Cleaning Machinery (Horse Drawn).
Austin-Western Road Machinery Co., The

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Austin-Western Road Machinery Co.

Street Paving Material.
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The Texas Co.

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Lewis-Hall Iron Works.

Surveyors' Instruments.
Kolesch & Co.
Lufkin Rule Co., The

Sweepers.
Austin Machinery Corporation.
Austin-Western Road Machinery Co., The
Elgin Sales Corp.

Tamping Machines.
Pawling and Harnischfeger.

Tanks, Water Supply.
Mensch, L. J.

Tar and Pitch.
The Barrett Co.
Philip Carey Co., The.

Tar Heaters.
Littleford Bros.

Tarvia.
The Barrett Co.

Testing Chemists.
Dow & Smith
Walter H. Flood
Howard, J. W.
Kirschbraun, Lester
Van Trump, Isaac.

Traction Engines.
Austin-Western Road Machinery Co., The

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Austin-Western Road Mach. Co.

Tractors.
Austin Machinery Corporation.

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Kalamazoo Fdy. & Mach. Co.

Trench Machinery.
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Kalamazoo Fdy. & Machine Co.
Pawling and Harnischfeger

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Barber Asphalt Paving Co.

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De Laval Steam Turbine Co.

Valves.
Coldwell-Wilcox Co.
Crane Co.
Flower Valve Mfg. Co.

Wall Coping.
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Warren Bros. Co.

Water Main Cleaning.
National Water Main Cleaning Co.

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Cast Iron Pipe Publicity Bureau

Waterproofing.
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The Texas Co.
Truscon Steel Co.

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Pennsylvania Salt Mfg. Co.

Water Softener.
The Refinite Co.

Water Works Supplies and Equipment.
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Cast Iron Pipe Publicity Bureau
Coldwell-Wilcox Co.
Crane Co.
Flower Valve Mfg. Co.
McNutt Meter Box Co.
Pennsylvania Salt Mfg. Co.

Wheeled Scrapers.
Austin-Western Road Machinery Co.

Winches, Vertical Capstan or Friction Drum.
Mead-Morrison Manufacturing Co.

Wire Rope.
American Steel & Wire Company

Windows (Steel).
Truscon Steel Co.

Wire-Cut Lug Brick.
Medal Paving Brick Co.
Metropolitan Paving Brick Co.
Murphysboro Paving Brick Co.
Springfield Paving Brick Co.

Wood Block (Creosoted).
Barrett Co., The
Republic Creosoting Co.

Wood Preservatives.
Barrett Co., The
Republic Creosoting Co.

MOTOR TRUCKS

Motor Trucks as Operated in Municipal and County Service and in Highway Transportation

THE SCOOP CONVEYOR
SAVES TIME, LABOR AND MONEY IN STORING AND RECLAIMING, IN LOADING AND UNLOADING CARS, TRUCKS AND WAGONS.
SAVES 6 to 12 MEN.
ENABLES MEN TO WORK FASTER AND EASIER. ELIMINATES MUCH SHOVEL AND WHEELBARROW WORK. DOES THREE TO FIVE DAYS WORK IN ONE.
OVER 2000 USERS
Write for Literature
PORTABLE MACHINERY CO., PASSAIC N.J.

Printed as insert to Municipal and County Engineering, Chicago, Ill., June, 1920.

MOTOR TRUCK OPERATION AND ACCOUNTING LVIII

Motor Hauling by Minnesota Highway Department

The following interesting data and discussion on the relative economy of motor truck and horse haulage as observed by the Minnesota State Highway Department, is contributed to the Motor Truck Section of MUNICIPAL AND COUNTY ENGINEERING, by Mr. A. M. Cooley, assistant engineer, 920 Guardian Life Bldg., St. Paul, Minn.:

"The information which we have in regard to the comparative cost of hauling by team and motor truck is as yet somewhat limited. The following facts constitute about all we are able to give out at present.

"A team will travel about 20 miles a day, and carries approximately 1¼ yds. per load, or 22-ton miles per day. The average rate for teams with drivers is from $8 to $10 a day. Thus the cost of team haul is from 40c to 50c per ton mile.

"Efficient truck haul depends upon a number of factors. In the first place the amount of previous experience in handling trucks which the concern has, will determine to a great extent the entire cost of operating them. Experience in engineering is absolutely essential in efficient operation in preventing waste of time, labor and material. However, this alone is not sufficient unless it is accompanied by a similar experience is the mechanical operation of the trucks. Familiarity with this side of the proposition is quite necessary if the results are to be satisfactory.

"A second factor in securing effective truck haul, is the operating organization. Only expert mechanics should be in charge. Often the ability to detect trouble in trucks before breakage occurs will prevent a costly accident. Correct lubrication and the proper inspection of tires are also essential in lowering the upkeep cost. Any overloading or speeding will increase the cost of operation considerably. A supply of spare parts is of value in keeping the trucks in constant working order.

"Still another feature in successful operation consists in using the right truck for the job. This depends upon climatic and road conditions. Only light trucks should be used on soft muddy roads and trucks with especially good traction and low gear ratio on sandy or hilly roads. A few of the counties have operated trucks at a higher cost per ton mile because they have ignored this fact.

"Considering these factors of successful truck operation, we have chosen Murray and Nobles Counties, Minnesota, as giving typical examples of the cost per ton mile of truck haul.

"Murray County has five 3-ton trucks, three of which are equipped with dump bodies and power hoists and are used for hauling gravel. The other two have cargo bodies and are used for hauling bridge and culvert materials to the job and general supplies to camp. During a period of six months, from July 1, 1919, to Dec. 31, 1919, these five trucks carried an aggregate of 44,900 ton miles at a cost of $8,581.06, including depreciation, interest on investment, insurance, wages of drivers, mechanical supervision, and gas and oil. This gives an average of $0.191 per ton mile.

"In Noble County in the month of February, 1920, there were four 2-ton trucks in operation. The aggregate ton mileage for these was 6,767 at a cost of $1,542.50, or $0.227 per ton mile.

"As we do not figure the depreciation on tires or parts but include these in the actual cost of operation, an exact statement of the cost per ton mile cannot be made until the trucks have been in use more than one season."

Duplex Truck Co. Installs Truck Express Line to Insure Delivery of Materials

There is a lesson for every manufacturer and every user of manufactured goods, in the fact that the Duplex Truck Co., of Lansing, Mich., refused to allow the railway situation to interfere with their production program. The world has applauded the sentiment that a good doctor should be willing to prescribe for himself, and this goes, also, in every line of business. Where sincerity exists those who advocate a policy for others are quite willing to adopt it themselves. It will occasion no surprise, therefore, to learn that during the recent industrial crisis when many factories were suspending operations in various departments or shutting down altogether, work at the Duplex factory continued; not an hour was lost and not a man was laid off. In fact, on the other hand, production increased and more Duplex trucks were given their finishing touches than during any similar period in less strenuous times.

The Duplex Limited trucks were called into active service and a regular express system was inaugurated and daily these high speed trucks rolled up before the factory fully loaded with supplies and material which had been transported from distant points.

From many cities in the East and West parts and supplies of all kinds were rushed to the factory by the trucks. Transmissions for the Duplex 4-Wheel Drive were carried from Syracuse, N. Y. Radiators and tubing, together with steel bars, were carried from Chicago. Trips were made to Detroit almost daily and loads of bar steel and miscellaneous supplies were rushed to the factory. Castings were carried down from Belding, Mich. Loads of hydraulic hoists were brought from Muskegon, Mich. Bearings were taken from Toledo to Wilkes-Barre. Differentials were rushed to Wilkes-Barre from Cleveland, these two shipments making a load of 6,000 lbs. on a 1½-ton truck on mountanious roads. The trip was made however in record time.

Less than 15 hours from Chicago to Lansing with combined loads totaling close to 5 tons was the record of two Duplex Limited trucks during this period of palsied railroad transportation. The record was made on unsettled roads.

Acme Trucks on Road Building in Northern Indiana

For almost three years the commissioners of La Porte

DIAMOND T

The Nation's Freight Car"

FIFTEEN years of highly successful engineering experience, devoted to every phase of your own specialized work—experience combined with close study, with skill, judgment and *proven* ability—

Could you ask a better recommendation of a *man* who sought to enter your employ?

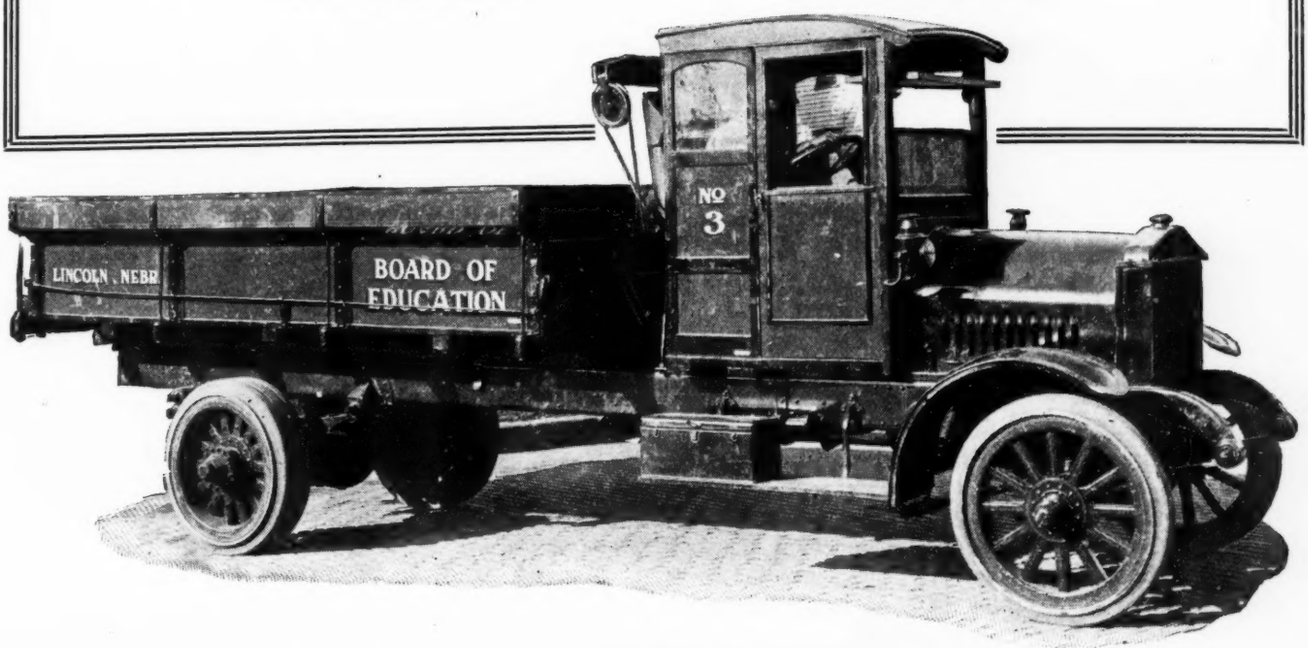
The same recommendation may well be asked of motor trucks. The proven ability of Diamond T trucks to lower transportation costs is backed up by 15 years of successful manufacture, of application, study and progress—all the way from *de luxe* passenger cars to high-grade, heavy-duty motor trucks.

We would like to explain the structural reasons for Diamond T super-performance. Why not write for detailed, specific information?

Diamond T Motor Car Co.

Builders of "The Nation's Freight Car"

4564 West 26th St. CHICAGO, ILL.



county, Ind., have used a growing fleet of Acme trucks in doing general county hauling and for road building purposes. Their first Acme was purchased in May, 1917. It was a 2-ton model equipped with the Acme standard combination dump and stake body. This equipment proved so satisfactory that another 2-tonner was added, equipped also with the same type of body. Since then various additional units have been added until at this time the fleet consists of two 2-tonners and three 3½-tonners, all with combination dump and stake bodies.

Mr. Reynolds, who has charge of the fleet, says: "All of the teams owned by the county were sold some time ago. At first it was the plan to retain teams for special work where it was thought they could be used to better advantage than the trucks. It was discovered, however, that the latter could not only take care of this work, but could do it quicker and cheaper. Consequently, the teams were sold."

Stone for the roads is distributed throughout the county from cars placed on several centrally located sidings. The stone is hauled several miles and unloaded by elevating the body and adjusting the opening in the tail gate to deliver a stream of stone of the right amount. The surface dressing (asphaltic) is applied by a wagon tank, pulled over the road by truck.

The Allen county, Ind., commissioners are operating two 3½-ton Acmes in the same class of service, each truck averaging 40 miles daily.

Kissel Trucks in the Municipal and County Field

C. H. Wittenberg, road contractor, of Hartland, Wis., bought a 3½-ton Kissel heavy-duty truck, equipped with dump body and hydraulic hoist, on April 4, 1918. It was used on highway work, hauling stone, screenings and gravel continuously every working day up to Jan. 1, 1919.

For several months the truck was laid up on account of winter weather that made the roads impassable, after which time Mr. Wittenberg again began operations and the truck was in continuous service during the entire year of 1919 on Waukesha county highway work. The truck averages 1,100 miles per month, carrying 4 cu. yds. of stone weighing from 10,000 to 11,000 lbs.

Washington county, Wisconsin, had a good appropriation for road maintenance and the commissioners investigated the cost of doing some of the work themselves instead of by contract.

First, they made sure of the available material from the many gravel pits throughout the county. Next the necessary crushing, screening and bin equipment and facilities for getting the material out on the road.

By getting a portable pit plant they found they could keep haulage distance to a minimum. A check of pits revealed maximum hauling distance of 4½ miles and minimum of 11 to 12 loads per day with a Kissel 3½ cu. yd. capacity truck.

The average daily loads figured about 16, giving them an average output of 56 cu. yds. per day with one truck. This size load, spreading material 3½ to 4 ins. deep would produce 13 to 14 miles in 150 days with one truck.

They purchased a crusher and a screening plant of sufficient capacity for at least 3 trucks in case they wanted to add to their truck fleet or for maintenance work as they progressed.

In doing this they developed special loading and dumping methods which saved time and labor—original with Washington county it is believed.

A "Heavy Duty" Kissel truck was employed with flat bottom dump body and horizontal hydraulic hoist. The usual method in building macadam roads is to cover the crushed stone with screenings, requiring two operations. They had the stone and the screenings, but wanted to do both in one operation.

After experimenting for several days they succeeded in this by loading the dump body 2-3 full of crushed stone and covering this with screenings. With this load the body was hoisted to dumping position—and gate tripped to a certain sized opening by the driver from his seat and the truck moved forward at the required speed to spread the material the desired thickness.

Economical Road Dragging With Duplex Truck

A Duplex 4-Wheel Drive truck, owned by Spaulding County, Georgia, recently performed some very economical road dragging work. There were 36 miles of road to be dragged and the work had been done previously by 12 mules under a double three-blade drag, which totaled 95 ft. of blade surface. The mules usually did the work in 3½ days. Over the same road, doing the same work, and using the same drag, the Duplex finished the job in just 8½ hours.

Use of Federal Trucks in the Building Industry

In Harrisburg, Pa., Wm. H. Murphy & Sons are using Federal dump trucks, not only to remove the dirt from all excavating jobs handled by them, but for hauling sand, gravel and other supplies to the job, and in the rush of work it is their aim to have the truck loaded in each direction, construction being carried on at one part of the job while excavating is still being done at another point.

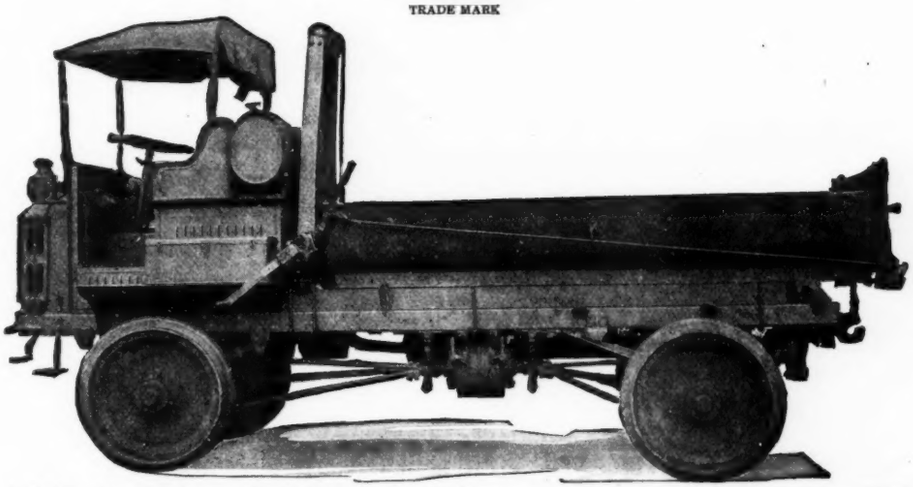
The George A. Fuller Company, one of the largest building construction firms in the world, with branches operating in every large city of the United States and jobs under way in many other parts of the world, are using Federals on many of their jobs, and are finding them more than satisfactory, not only in their work, but in the operations of their many sub-contractors.

Not only is the question of the transportation of materials an important one, but there is a great amount of equipment to be hauled in connection with any big construction job, as well as general utility hauling and quick deliveries to all parts of the job, and for this H. Schmitt & Sons, Inc., of Milwaukee, are using a 1½-ton Federal with express body, in addition to their heavier dump trucks.

Among the larger exclusive excavating contractors who are using Federals is the Atlas Excavating Co. of Detroit, who operate a fleet of 3½-ton dumps, and during the past few months they have been kept on the job 24 hours a day, in spite of the extremely severe weather of the winter months.

The Joplin Cement Co. of Joplin, Mo., are operating two 1½-tonners with platform bodies for making deliveries of all sorts of builders supplies. They advise that about a year ago they purchased their first two trucks, a 1½-ton Federal and an internal-gear driven truck, and that during the year they have had no expense in connection with the upkeep of the Federal, while the other

TRADE MARK



A Columbian Lightning Hoist and Dump Body mounted on one of the Government FWD trucks. The Indiana State Highway Commission has 65 trucks with this equipment.

Performance Counts In Road Building!

That is why the

Columbian Lightning Hand Hoist

PATENTED

is so often specified when purchasing road equipment. Its record of successful performance in the past assures you of its ability to serve you satisfactorily and economically in the future. No matter what kind of a truck you are using, the COLUMBIAN LIGHTNING HOIST in connection with a Columbian Steel Dump Body will increase the efficiency of your road building equipment by it's speed, capacity, and ease of operation.

The COLUMBIAN LIGHTNING HOIST is based on mechanical principles so simple that there is practically no chance for it to get out of order, yet so sound that one man can easily dump a 5-ton load. While it has been built with the idea of quality rather than price, yet the first cost is so reasonable that this, together with the absence of maintenance costs, makes the Columbian Hoist a most satisfactory purchase from the standpoint of economy.

Write us today for our illustrated circular No. 96 and learn how Columbian Dumping Equipment can serve you.

COLUMBIAN STEEL TANK CO.

"TANKS FOR THE WORLD"
1519-1625 WEST 12th STREET

"ESTABLISHED IN 1894"
KANSAS CITY, MISSOURI.

truck was so expensive that they have recently replaced it with the second Federal.

Jos. Bleau & Son, brick manufacturers of Watervliet, N. Y., advise that they are using their truck on a three-mile haul where, as Mr. Bleau goes on to say, "We formerly hauled 1,250 brick with a team and required about 2½ hours, while now we haul 3,000 brick with the truck and make the trip in about 45 minutes. The truck very easily does the work of three teams and we are pleased with its performance."

J. A. Glenn of Taunton, Mass., is using 2-ton Federal dump trucks in his general contracting business, as are George Brooks & Son, General Contractors of Paterson, New Jersey, for all the excavating and their deliveries of materials. The Ray-Jones Company of Shreveport, operate a fleet of four dumps, in their work throughout northern Louisiana.

Overspeeding—Dispatching and Routing—Fleet Operation

Some very interesting and timely observations on overspeeding, dispatching and routing, and fleet operation, recently issued by the Publicity Department of the Pierce-Arrow Motor Car Co., are here reproduced:

Overspeeding—Overspeeding is not only dangerous to others, but like overloading, is a factor which greatly lessens the normal life of your truck. Most trucks are equipped with governors to prevent excessive driving speeds. It is just as essential to keep down the speed in coasting.

A heavy truck in motion represents a tremendous amount of energy whose destructiveness increases at a much greater ratio than the increase in speed. It therefore requires much more effort to control and it can do untold damage should it get beyond the driver's control.

Excessive speed causes excessive wear. The driving shafts are designed to run at certain speeds below their critical or bending speeds. Whipping of drive shafts does not tend to increase gradually but is almost instantaneous in its action once the critical speed is reached. Much damage not only to itself but to surrounding parts may be the result of a shaft whipping out of its proper position. The engine flywheel and clutch parts may also be damaged beyond repair should they run at an excessive speed.

Truck tires, particularly the usual solid type, are rapidly destroyed by abnormal speeds. It is here that the cost of over-speeding is most quickly felt by the truck owner.

In fairness to yourself and to other users of the highways do not tamper with the governor on your truck and do not permit of driving beyond a rational speed if your truck is not so equipped.

Dispatching and Routing—Upon intelligent dispatching and routing of trucks depends their practical operation. In fact, these are the chief duties of the superintendent in charge of the operations of the trucks. His ability to keep paying loads moving will measure the success of their service.

System should underlie the work of the dispatcher and router. He should have a complete knowledge of the day's work at least 24 hours in advance if possible. Upon this information he can chart a schedule that will eliminate all waste time, distance and motion.

To route the trucks, an intimate knowledge is necessary of the geography and topography of the scene of operations, whether it be city or rural territory. The dispatcher and router should know the density of traffic at various hours of the day. He should know the best hours for loading or unloading at various shipping or delivery points.

It is the aim of the dispatcher to keep truck traffic moving past his shipping platform in a cycle. He must avoid, if possible, the congestion of his entire fleet at the shipping platform, compelling part of the trucks to remain idle while waiting for loading or unloading crews.

To aid him in assigning the loads to units of the fleet and to map out time-saving schedules for their operation, the dispatcher usually makes use of a dispatch sheet. This record will show at a glance the nature of load, the distance, the time of departure, the destination and the probable time of return of any truck in the fleet.

That the installation of an efficient dispatching system is profitable, is proved by the experience of an operator of 24 large trucks, who in one year saved close to $30,000 in operation and maintenance expense through the elimination of idle time and wasted travel.

Fleet Operation—Organization is just as essential to the efficient operation of a group of trucks as it is to any other phase of business activity. Only by means of an organization can a fleet owner or manager direct the operation of his trucks intelligently and economically.

The personnel of a fleet organization is divided into two groups, one of which is the maintenance division, and the other the operating division. In some of the larger fleet organizations, an inspection division has separate identity, but in the smaller ones this inspection service is directed by the maintenance division, or is performed by the truck manufacturer himself.

The maintenance division should be headed by a superintendant who is a practical mechanic. He may have as many assistant mechanics as is necessary to maintain the fleet in good mechanical conditions. Washers and greasers are included in his department, and work according to a well-planned schedule.

The operating division should be headed by a man who is a practical dispatcher. He usually has direct charge of the drivers, who report to him daily as to mileage traveled, work accomplished, etc. The head of this division should furnish the fleet owner or manager with weekly or monthly record reports, showing the performance of each truck in complete detail.

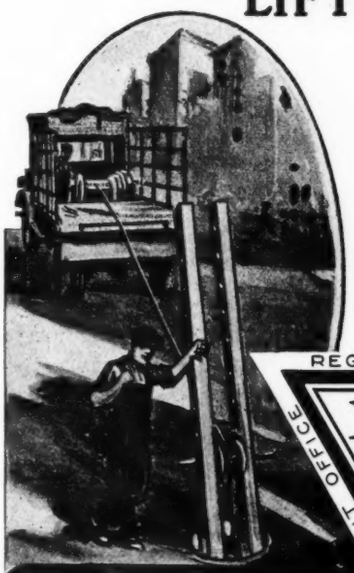
The larger fleets usually require a stockroom for spare parts, unless the manufacturer's service station is close to the base of operation. Fleets of less than 10 trucks seldom need a stock of parts, except for minor ones, such as spark plugs, fan belts, grease cups and such. The larger fleets require in addition extra springs, bearings, valves, magneto parts, etc. Some of the largest fleets use the unit system, keeping on hand a spare motor, transmission, rear axle and other units in addition to sets of springs and other essential parts.

Renewed Sentiment for Better Highways Follows Rail Strike

A wave of renewed sentiment for better highways that will hold up under every sort of motor vehicle traffic, including heavy commercial traffic, will sweep the country as a result of the statements of big shippers who resorted

MEAD-MORRISON SERVICE

LIFTS THE LOAD OF INDUSTRY

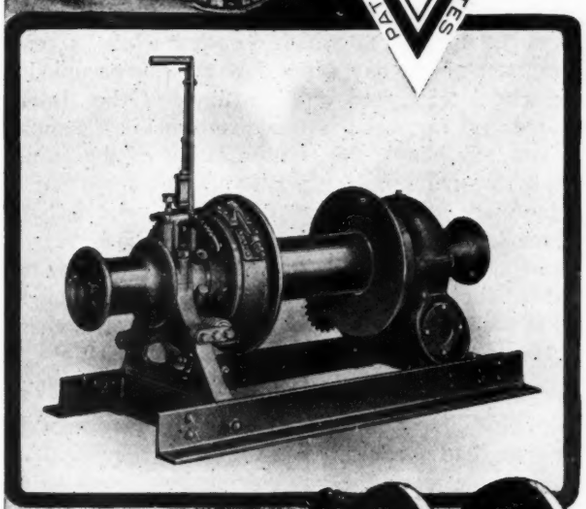


More productive hours! Two hours a day—for each man on the truck and the truck itself—over 600 hours a year for each—over 1800 hours when the truck carries two men.

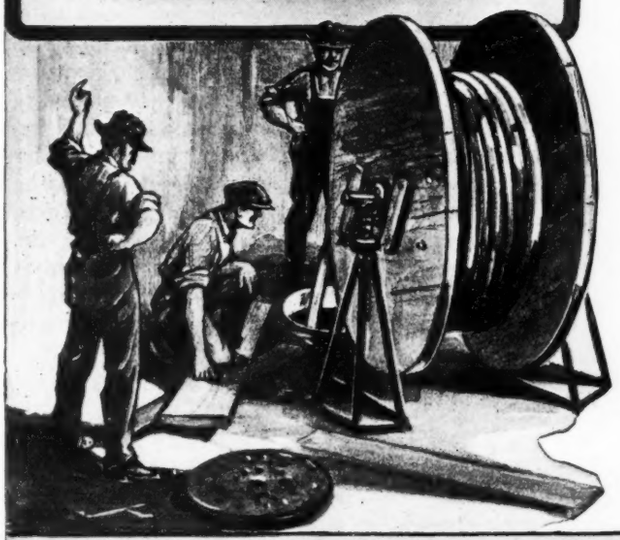
Such is the demonstrated achievement of Mead-Morrison Engineers, proving indisputably that the ideal of Mead-Morrison—to increase the productive hours of industry—is being carried out in a sound, practical way in

REGISTERED IN UNITED STATES PATENT OFFICE
MM CM

MEAD-MORRISON Truck Winches



Both types of Mead-Morrison Winches, the Vertical Capstan and the Friction Drum, have thoroughly demonstrated their practical worth in reducing costs in handling heavy, bulky loads. The Friction Drum Winch, shown pulling telephone cable through the conduit, is but another illustration of its worth in reducing costs on the "out-of-the-ordinary" job. In this case it actually released five men for other work, and with fewer men made a 50% increase in the amount of cable installed.



The Mead-Morrison Motor Truck Winch Folder conclusively proves there is a real saving when you "let the engine do the work." Send for one.

MEAD-MORRISON
MANUFACTURING COMPANY

626 Prescott St. EAST BOSTON, MASS.

to motor trucks to save their business from ruin during the recent rail strike, in the opinion of President E. A. Williams of the Garford Truck Co., who has been making analysis of the losses and gains to industry in the transportation crisis that crippled commerce from one end of the country to the other and the effect of which still is being felt in many sections. He says:

"It is obvious, of course, to anyone, that a universal outcry is being made already by shippers and business men who saw the need of better roads when they turned to the truck for relief during the rail tie-up, but this outcry is only the forerunner, I believe, of a movement that will crystallize into a definite country-wide campaign for better highway legislation.

"The press probably has done more than any other institution to agitate the question and keep it before the minds of men who already are wrought up to a point where they will plunge at the first suggestion into a movement for the improvement of roads and complete overhauling of our present highway maintenance system."

In this statement Mr. Williams referred to the heated editorial discussion of the subject by a number of the foremost metropolitan dailies of the nation. These journals, observing the manner in which the motor truck fell into the harness and carried the bulk of transportation during the period the switchmen were on strike, virtually demanded, curtly in some instances, that new road programs be designed. They pointed to the supreme test to which the truck was put in the emergency and the manner in which it acquitted itself with full honors, while the roads, in numerous localities, failed to meet the requirements of commercial duty.

A Good Truck Can Stand Bad Treatment

The Walworth Co. of Kewanee, Ill., makers of metal products requiring the use of sulphuric and other acids, own a Diamond T truck. A pond near their factory has been the recipient of hundreds of gallons of these waste acids for a number of years. Among its other duties the truck was engaged in hauling and dumping ashes to fill in this so-called acid pond. During the winter it was the custom to drive the load out on the ice and dump, which worked admirably until the driver happened to carry out a load of red hot cinders fresh from the boilers. The hot cinders went through the ice with a splash, followed by the truck.

The rear part was immersed about 72 hours, and the motor about 6 hours, or, in other words, long enough thoroughly to complete the test. It took a crew of 15 men 3 days to get the truck out of the "acid pond." The remarkable feature of the accident is the fact that this truck is today in excellent running condition and it was necessary only to give it a general cleaning, put clean gasoline in the tank, new oil in the engine and let the coil dry out; all of which was done in six hours.

Using a Tractor on Street Grading

The Hornaday Construction Co. of Memphis, Tenn., have been using a Lauson tractor on exceptionally heavy grading work. The tractor has been used in loading Maney Four-Wheeled Excavators. These wheelers are, in loading, forced into hard street earth and are filled to their full capacity of 1 cu. yd. The tractor is used in place of a four-up team. The Hornaday Co. was never able to hook up enough mules to load the wheelers properly and for that reason the tractor was secured.

When Country Children Motor to School

Better schools in the rural districts will help to "keep 'em down on the farm," a consummation desired by all. To improve country schools, several small ones must be consolidated to form a school large enough to provide proper teaching and equipment. This will mean long distances from many farm homes to the school house and presents a new problem in transportation. In California, children ride to the El Cajon Valley Union High School in a 1-ton Federal truck equipped with a special bus body. This body has one door. The seats are arranged crosswise, and the end ones fold up to leave a passageway. Thirty-one passengers can be comfortably seated in this little bus.

Naturally the services of this truck are required but twice a day to bring the students to school and take them home again. It makes two trips, each 8 miles, traveling 16 miles per day. As school is open but five days, the average per week is 80 miles. Records show that this truck actually consumes but 5 quarts of gasoline per day, 6¼ gals. per week, making 12.7 miles per gallon.

The Anaheim Union School, which covers a somewhat larger territory, is operating a fleet of several Federals with much the same body construction.

The same plan in various forms is in operation not only in many districts in California, but at widely scattered points, throughout the United States. The plan varies in different localities. Some school boards are using adaptable bodies, which do other work on contract during part of the day when they are not occupied with their school trips, and on Saturdays. Other lines are operated by farmers co-operative trucking companies, which merely handle the transportation of the pupils, at a fixed rate per pupil or per family, as a part of their regular work. In still other places, the work is handled by some farmer who owns a truck, and who increases his revenue and cuts the idle time of his equipment by taking to school the children of other farmers in his neighborhood at the the same time that he takes his own, charging a small fare for each trip.

Economy of Trucks as Demonstrated by White Trucks

Boyd Williams, a road contractor of Lawrenceburg, Tennessee, had used teams in his hauling for years. When the war came along the government bought up so many horses for war service that one day the contractor found himself with a rush job on his hands and no teams available. "I didn't know anything about motor trucks, but I had to have some to save me," he says. "I bought two 5-ton Whites and put them to work hauling chert on the Jackson Highway, I have never regretted the purchase."

The State Road Commission of Utah, owner of a fleet of White trucks, rents these out to the counties in the state for road building purposes. The depreciation of the trucks is figured at so much a day and the rental is made to cover depreciation only, the counties standing all repair expenses together with oil and gasoline.

The four 5-ton White trucks owned by S. Monroe & Son Co., contractors of Portsmouth, Ohio, have been in service almost continually for four years and make from 60 to 80 miles a day hauling brick, sand, gravel and cement on state road work. "We are moving our material with trucks for much less than we could do the work with teams, and, best of all, we are getting it there

DUPLEX TRUCKS

BUILT FOR BUSINESS

Duplex Limited Specifications

Capacity—Normal Load 3000 lbs. Maximum allowable weight including body 5000 lbs.

Speed—5 to 30 miles per hour on high speed. The Duplex *Limited* will attain and *hold* a speed of 25 miles per hour with a full load, and *normal engine speed.*

Motor—4 Cylinder enclosed type, water cooled. Cast enbloc. Bore 4-inch, Stroke 5¼-inch, 3 Point Suspension.

Clutch—Multiple Dry Disc. 5 plates—9-inch diameter.

Transmission—Selective sliding gears—direct on high.

Electric Lighting and Starting—Westinghouse—with 157 am. hr. battery.

Carburetor—Stromberg 1¼-inch.

Gasoline Tank—Under cowl—gravity feed. 18 gallon capacity.

Cooling—Special Duplex design Radiator with cast tanks and finned head. Spirex core. 18-inch fan driven by 2-inch leather belt.. Centrifugal water pump.

Oiling—Force and splash feed.

Final Drive—Worm.

Front Axle—Drop Forge I-Beam 2⅝-inch deep.

Rear Axle—Straight or David Brown type of worm gear, with 5.51 ratio.

Springs—Semi Elliptic—front and rear.

Wheels—Heavy Artillery type—12 spokes 1¾-inch square.

Tires—Pneumatic Cords 35x5 front; 38x7 rear.

Wheelbase—145 inches.

Equipment—Windshield; Electric starting and lighting; Ammeter; Boyce Motometer; Speedometer; Electric Horn; Tools; Jack; Rim wrench. Front fenders; Alemite High Pressure Lubricating System; Driver's seat without extra charge. (Power tire pump at extra charge.)

Duplex Four-Wheel Drive

3½ Ton Capacity

America's Leading Heavy Duty Truck

The Duplex Limited

A Wonderful, Medium Capacity, High Speed Truck That is Establishing Remarkable Operating Records

* * * * *

Pneumatic Tired—Full Electric Equipment—Speed 5 to 30 Miles per Hour on High with Full Load—Here is a Speed Truck That Can Really Stand Speed Work.

* * * * *

THE need of the day is quick, sure, economical transportation. Goods must be *kept moving.* The fastest truck is the most economical truck, of course. But speed must be coupled with mechanical ruggedness.

The difficulty that users of medium capacity trucks have had to face is the fact that the general run of speed trucks couldn't stand steady work. They racked and strained themselves to pieces too quickly.

The Duplex Limited was developed specifically to meet this need. As the result of our years of experience in originating and building the Duplex 4-Wheel Drive *Heavy Duty* truck we knew how to build trucks that *last.*

The Duplex Limited is today probably the smoothest running truck on the roads. Loaded to capacity it travels along easily and steadily and *without strain.* Its motor is so large, so powerful that maximum road speed is obtained with the motor turning over only at *moderate speed.*

The Limited was designed deliberately for *speed.* It was *designed for* pneumatic tires—and not merely equipped with them. No excessive vibration or shock or strain. It works *easily* and therefore wears *longer.*

It was designed and is built to work—not to travel empty. And it stays on the road—not in the repair shop. It is strong and rugged and safe for *speed* work as the famous Duplex 4-Wheel Drive is for heavy work.

The way it handles; its strength and ruggedness; its ability to keep going without tinkering—these are the reasons why the Duplex Limited is all over America meeting with a wonderful success.

Write us for folders which give mechanical details—and show its mechanical superiority. Ask your Duplex dealer to demonstrate the Limited. You'll get a new idea of motor truck value.

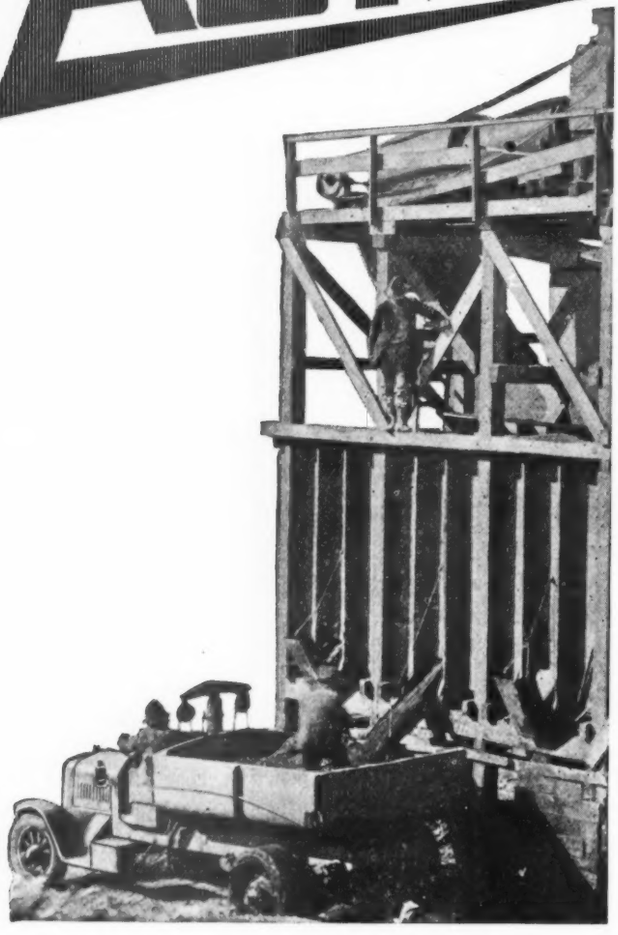
DUPLEX BUILT FOR BUSINESS

Duplex Truck Company

Lansing · Michigan

One of the Oldest and Most Successful Truck Companies in America

ACME



Acme-Hauled From Chute to Dump

HAULING from the storage chute to dump with a five-ton Acme is one link in the operations of Thomas McKusick of Hibbing, Minnesota —but it is a most important one. The constant operation of the screen at one end and timely delivery at the other depend upon the steady, reliable performance of this five-ton Acme Truck. And his entire satisfaction with Acme performance is a logical result of the principle of "Proved Units—Acme Constructed."

Hundreds of Acme owners throughout the country echo Mr. McKusick's approval. The results of a recent country-wide investigation will prove very instructive to the prospective truck buyer. Write for complete information.

Built in 1, 1½, 2, 3½, and 5 ton models.

ACME MOTOR TRUCK COMPANY
192 Mitchell Street, Cadillac, Michigan

The Seal of Dependable Performance — *Trade Mark Reg., U. S. Pat. Office*

when needed," says Gilbert S. Monroe, secretary and treasurer of the company.

Onondaga County, New York, furnishes a good example of what trucks can do in road building work. This county, whose roads are among the best in the state, owns a fleet of 19 Whites, 14 of which work continually on road construction and maintenance. Since 1911 Onondaga County has constructed 145 miles of improved roads and is going ahead at the rate of about 50 miles a year.

Most of the stone used on the roads is hauled from the county-owned Jamesville Quarries. In 1918, 20,203 tons of stone were hauled out, most of it in White trucks. During 1919, the daily average removal was 25 truck loads, or 125 tons. The fleet in this work averages 70 miles a day, although on some of the longer hauls the trucks travel 90 miles daily.

Frank E. Bogardus, County Highway Superintendent, in his 1918 report, points out that considerable saving was effected by the purchase of five 5-ton trucks that season to haul stone directly from the quarries to a distant point in the county. Some of the material up to that time had been shipped by rail to distant points of the county and then distributed from these points to road jobs with trucks.

The hauling of earth is quite a factor in the truck work of Onondaga County, for county officials endeavor to keep all road grades down to a maximum of seven or eight per cent. which means many deep cuts and fills.

In the summer of 1919, Thomas, Bennett & Hunter assumed an extensive road contract on the Littlestown Pike, between Westminster and Littlestown, Md. The specifications called for the laying of a concrete highway, 16 ft. in width and 8 ins. in depth.

"We calculated at the start that if we could work uninterruptedly six days a week during our season we could make money by laying 220 lin. ft. of concrete daily," says Mr. Thomas. "We knew, however, that there would be many days, on which because of rain or other conditions, we could not work. This meant that we would have to lay considerably more concrete each working day."

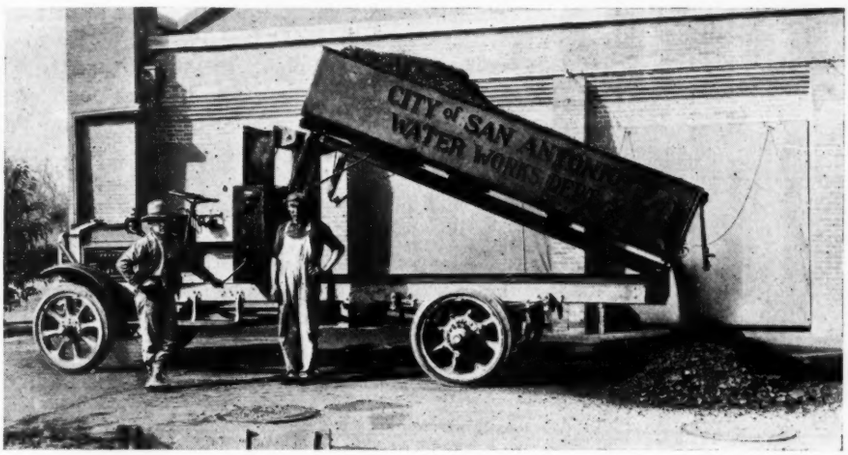
Three White trucks were put to work on the first section of the road, a stretch of 2¼ miles. They hauled crushed stone, sand and cement from a railroad siding, the average distance traveled by each truck on each round trip being five miles. Practically all of this distance was over dirt roads.

Sixty days elapsed between the start of the work by the grading and drainage gangs and the completion of the 2¼-mile stretch of concrete. The actual number of days spent in laying concrete, however, was only 41. This meant that on each working day more than 288 lin. ft. of concrete highway was laid.

A Cleveland road contractor, who owns a fleet of 17 White trucks, accomplished a saving of $40 a day with three of his trucks on the job of hauling materials for the 6¼-mile Elyria-Twinsburg road near Cleveland.

This saving applied to the hauling of 12,000 cu. yds. of gravel and stone, 12,000 barrels of cement, 50,000 ft. of 4-in. drain, 17,000 cu. yds. of cinders and 400,000 brick.

The road is known as a two-course cement road,



Federal Truck equipped with hoist and dump body operated by the Water Werks Department, San Antonio, Texas.

A Federal—
For Dependable Hauling

When you choose a Federal for your city, township or county, you can feel certain of three things:

First, that your judgment of the ***rightness*** of the truck is correct. Ten years of successful truck building experience has contributed the assurance that the design and workmanship of this truck is right.

Second, you are certain that you have chosen a truck that will ***stay*** right. Federal trucks have been in continuous successful use by cities and towns for periods of well over ten years.

Third, that the dependability which you have purchased in a Federal truck is not expensive. Federal records of economy are second to none—anywhere. The Federal you purchase will give complete satisfaction in its low upkeep and operation costs.

There is a Federal capacity to fit the need you have of a truck. The Federal dealer in your city will appreciate the opportunity of demonstrating it to you.

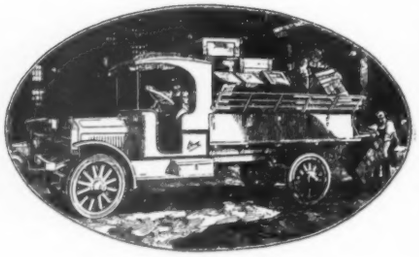
"Traffic News," an interesting magazine of transportation, sent free on request.

FEDERAL MOTOR TRUCK COMPANY
35 FEDERAL STREET DETROIT, MICHIGAN

This is the sign of the Tenth Year Federal, a sign significant of ten years of success in every field of truck transportation.

Another FEDERAL

GARFORD



Not a "one-job" truck, but built for all-round serviceability on a definite basis of *Low Cost Ton-Mile*—this is what the thousands of Garfords are demonstrating year after year.

City Indianapolis
State Ind. Date June 6

The Garford Motor Truck Co.,
Lima, Ohio.

Gentlemen:

The following is the record of my our Garford motor trucks:

Cap'c'ty 1½ tons, Yrs. of service 3, Avr. miles gal. gas 10, Repairs $ 40 Tot. Mil'ge 54000
Cap'c'ty ____ tons, Yrs. of service ____, Avr. miles gal. gas ____, Repairs $ ____ Tot. Mil'ge ____
Cap'c'ty ____ tons, Yrs. of service ____, Avr. miles gal. gas ____, Repairs $ ____ Tot. Mil'ge ____
Cap'c'ty ____ tons, Yrs. of service ____, Avr. miles gal. gas ____, Repairs $ ____ Tot. Mil'ge ____

(Signed) George Hohn

Remarks: I have driven a good many trucks The Garford is the best all round truck

Garford
Lima, Ohio

Returns from a recent investigation among 4,000 Garford owners show 97.6% are 100% satisfied.

TRUCKS

although the hills are paved with brick. The average grade is 7 per cent. although some grades run as high as 10. One hill, 3,600 ft. long, has a rise of 290 ft.

During 1915, when the work started, the trucks worked day and night. The loading point was six miles from the starting point of the job, and the Whites averaged six trips every 10 hours. In 1916, unloading was done at the Strongsville, Ohio, station, which cut truck haul to four miles, but this was over a road full of chuck holes and including several sharp grades. Eight trips in ten hours were averaged on this route.

"Each truck performed the work of twelve teams, saving more than 50 cts. a yard," says the superintendent. The trucks saved at least $40 a day over the price we would have had to pay to haul the material with teams.

The Gramm-Bernstein Motor Truck Company Lima, Ohio U.S.A.
GRAMM PIONEER BERNSTEIN
Manufacturers of High Grade Chainless Motor Trucks in Pioneer Days

All Gramm-Bernstein worm drive models carry, as standard equipment, accessories which are essential to the satisfactory operation of any truck, and which are worth $550 to $600 at today's prices.

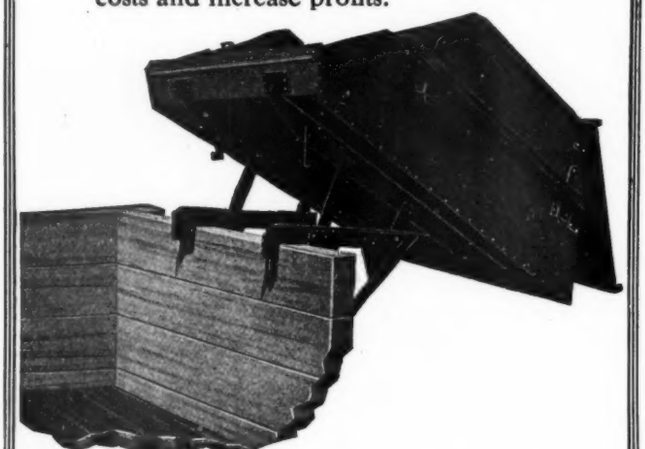
The Gramm-Bernstein Motor Truck Co.
LIMA, OHIO, U. S. A.
Builder of the First Liberty (U.S.A.) Truck

THIS IS THE
Heltzel "Lightning" Loader Skip

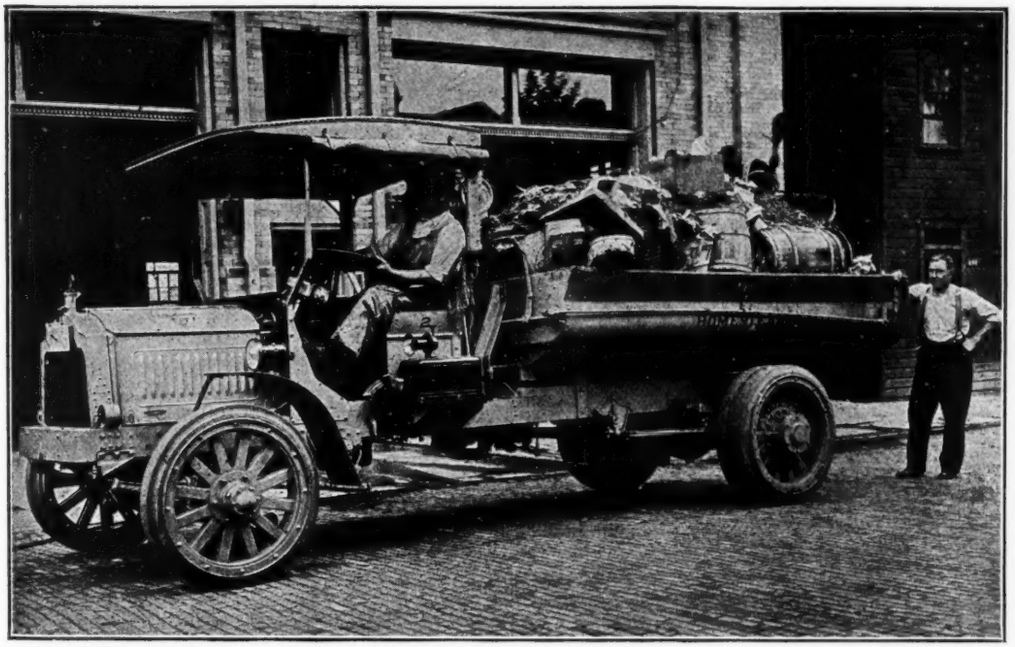
It is perfectly designed and built for its special purpose—strong and rigid, properly reinforced and fortified.

Collapsible—readily moved about.

Adjustable to any condition—high car, low truck, or vice versa—easily operated. It will decisively cut operating costs and increase profits.



The Heltzel Steel Form & Iron Co.
WARREN, OHIO.



Packard Truck in street cleaning service. How long will the gears of the average assembled truck stand up under the constant stopping and starting required of a Street Department truck.

Why Packard Discarded "Ton Rating" for Packard Trucks

REASONING as *transportation engineers,* the Packard Company has believed for years that the arbitrary factory "ton rating" system was bound to become obsolete as soon as sufficient facts on transportation could be known.

These facts are now at hand—made avaliable through more than 7000 Monthly National Standard Truck Cost System Reports covering a period of two years.

These reports confirm what Packard has so long foreseen—the fallacy of rating a truck simply on the tonnage capacity of the chassis and engine under normal conditions.

They have proved again and again the sound Packard practice of rating a truck with *all* the transportation factors in mind—character of roads, grades to be met, speeds to be maintained, and the chances of overload, etc.

Compare a Packard Size G, Model E, Truck, developing nearly 6700 pounds traction at rear wheels and able to pull a 28 per cent grade on low gear; with the typical "6-ton Truck" of competing make, developing less than 4700 pounds traction, and able to pull only a 20 per cent grade!

The Packard frame both strong and flexible—made of rolled channel steel, not pressed steel.

Packard *solid tired* trucks governed at 11, 13, 15, 18 miles per hour, by the Packard transportation expert in touch with the actual job.

Today, as always, Packard is selling *transportation.*

Hereafter each Packard Truck will be designated by *size* and *model.*

The rating will be made on the ground, *for the job,* by the local Packard engineer—selected for what it will do in the individual customer's needs, and with all his *actual conditions* in mind.

"Ask the Man Who Owns One"

PACKARD MOTOR CAR COMPANY, *Detroit*

Kissel Dependability

"The result of 14 years transportation engineering—plus designing and construction experience of trucks in use; a definite Kissel policy of efficient factories, organization and capital to build trucks that actually meet and stand up under respective transportation needs"—

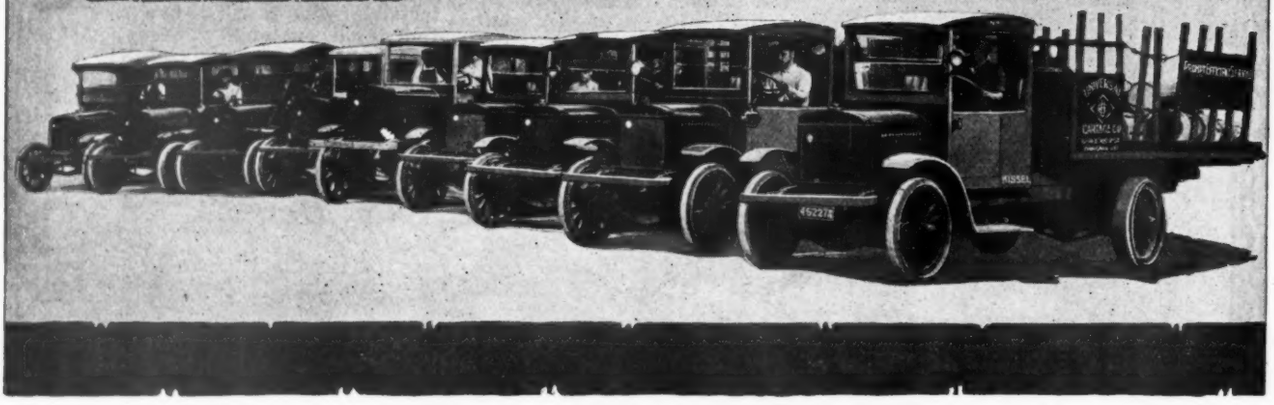
Standardizes Transportation Equipment

Because owners experience such unusual satisfaction that they standardize on Kissel Trucks as their increased requirements demand — is the reason why the Kissel single unit owners of today become the Kissel fleet owners of tomorrow.

Five sizes—specifications, catalogs from nearest Kissel distributor or

KISSEL MOTOR CAR CO., Hartford, Wis., U. S. A.

The Universal Cartage Co. of Milwaukee, started with one Kissel Truck (above), "Our standardizing on nine Kissel Trucks (below) has revolutionized our transportation efficiency," says President Vander Heyden.



THE INFLUENCE
OF THIS MOTOR TRUCK SECTION OF
Municipal and County Engineering

is far-reaching. Even the publishers are continually learning interesting things about the extent of this influence. It is to be expected, of course, that contractors, municipal and county engineers and officials, good roads advocates, and all leaders of thought in the motor truck industry, should find this department of real interest. But in one day recently two letters were received, bringing to light two additional types of extraordinary interest.

The first letter, from a firm of prominent consulting civil engineers in a central city, asked if it were possible to secure a complete file of these sections in bound volumes.

The second letter was from the most conservative and, according to many, the best engineering college in the United States. A professor in this Eastern college wrote:

"I am endeavoring to collect data on highway transport engineering. In connection with a study of haulage costs by motor trucks and trailers, I have been much interested in the Motor Truck Section, printed as an insert in Municipal and County Engineering.

"I should like to know whether you could furnish me with a complete set of these Motor Truck inserts since this section was instituted. It would be a valuable addition to my files, especially if a course on highway transport engineering should be added to our curriculum. Although we have Municipal and County Engineering in our Civil Engineering Library, I do not wish to take out the Motor Truck Sections as I believe they should be preserved in the bound copies at the end of the year."

This section is intensely practical and the publishers are frankly gratified to know that it bears so well the test applied in the name of pure science. A more eloquent testimonial as to the genuine merit of the section could not be asked than this letter from a prominent educator who, while interested in the economics of highway transportation, has no commercial interest in the subject. His letter was, therefore, a source of satisfaction to the publishers and indicates, in conjunction with letters from many buyers and users of trucks, that this section is well balanced and is a great influence working for motor highway transportation.

—The Publishers.

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EDITORIALS

WATER WORKS ISSUE

Special attention is paid to water works matters in this issue, primarily because of the annual convention of the American Water Works Association at which this number will be exhibited. More than the usual amount of space is devoted to this subject, for this issue, and a number of very interesting and practical water works articles are presented. These articles will be of great interest to water works men, naturally, and they are also of unusual interest to the general reader. The Water Works section provides municipal and county engineers, generally, an opportunity to note the matters now occupying the attention of their contemporaries in the water works field.

BIND YOUR COPIES OF M. & C. E.

The present number of this magazine completes the fifty-eight volume, and a complete index to this volume will be published in the next issue for the convenience of those who make a practice of binding their copies. A great many of the readers take this means of preserving their magazines for future reference. The practice is a good one and every interested reader would do well to adopt it. The work is inexpensive and it can be done in almost any locality.

The publishers are often reminded of the wisdom of binding the magazine by letters from subscribers asking for references to articles on various subjects, and asking for back copies containing matters of present interest to the individual. The point is that workers in this field move about more or less, not only from place to place, but from one department to another, and from city to county service or vice versa. Thus the county engineer of today may have less than an academic interest in water works matters, but if a political upheaval lands him in a city water department his interest will quickly change. He will do well to preserve the best of current literature on all municipal and county engineering subjects so as to have good backing when he makes a change in his work.

Oftentimes we are requested to furnish back copies; usually we can do so but not always. Every issue of this magazine is worth preserving because so many of the articles are written for our exclusive use and do not appear elsewhere. No matter what other journals may be read this one should be preserved for it contains much of permanent value. We suggest that those who have not bound their copies before adopt the practice at this time.

WHEN A MAN WRITES A GOOD ARTICLE

When a man writes a good article for a magazine of this character it is the practice of some readers to write him complimenting him on his presentation and thanking him for making a useful and interesting contribution to the literature of the profession. Such a practice, if generally observed, would operate greatly to enrich such literature.

Very often readers write to the editor indicating that they have found much satisfaction in reading this or that article. Such letters are always welcome as they indicate that the magazine is producing the character of material the readers want. When noted, these letters are often forwarded to the contributor.

While publishers realize that it is only the occasional man who will occasionally write such letters, the man who writes but one article a year, or in several years, may fail to understand silent approval. He is not sure he has been of service unless told so.

Many engineers could write interesting articles if they would and there is no better way to encourage the writing of more good articles than to express appreciation of those published. Engineers are often slow to write, fearing that what they have to offer will be criticised adversely. We have not found engineers especially critical of the writing of their contemporaries in recent years. The engineer is growing broader in every way and does not indulge narrow prejudices as he did ten years ago. Then, many engineers never wrote and were inclined to criticise and ridicule those who did. The result was that only the monumental works were described and matters of ordinary interest were ignored by contributors as there were too many able and willing, not to say anxious, to criticise such writings. After one unhappy experience many never got up courage to write a second article.

But there has been a change in this matter, we confidently assert. Anyone who is public spirited enough to write today, is sure of respectful attention. Knowing that readers are appreciative we hope they will take the time to write to authors of good articles along the lines here suggested. This is a constructive practice.

DESIGN OF BITUMINOUS PAVEMENTS OF FINE AGGREGATE

By R. Keith Compton, Chairman and Consulting Engineer, Paving Commission, City Hall, Baltimore, Md.

This article is intended to cover in a practical manner, important factors and points in the design of bituminous pavements of fine aggregate, so that the layman or untrained engineer may not be misled in believing that any pavement of any design or type is good enough. The writer is convinced that each of the standard types of pavement has its place, but it would be foolish to take the stand that any particular type can be laid anywhere, under any and all conditions and produce good results. A bituminous pavement of fine aggregate is commonly known as sheet asphalt, its surface course consisting of asphalt cement mixed with carefully graded sand and fine mineral filler, such as limestone dust or Portland cement. When stone is added to the mixture, it then approaches the coarse aggregate.

Where Sheet Asphalt Pavements Are Applicable

For all types of motor traffic, generally speaking, a properly designed and constructed sheet asphalt pavement more nearly approaches the ideal than any other type. It will sustain a very heavy amount of traffic, preferably quick moving, light or medium loaded vehicles; for instance, such traffic as prevails on many business streets. It is not claimed to be particularly adapted to slow moving, dense traffic; some block pavements will outlast it under such conditions. It must have some traffic to cause the kneading action necessary for it to retain those properties which constitute its life and durability. Therefore, before deciding on this type of pavement or any other, the engineer must consider the extent, volume and character of traffic, the grade of the street, width of paved driveway, whether or not street railway tracks exist, character of section to be served, whether business or residential; whether noise is a factor, and it generally is, and whether or not the street is in close proximity to a water front as bituminous pavements will not withstand moisture; they must have a chance thoroughly to dry out. Generally speaking, an 8 per cent. grade is the maximum for sheet asphalt on a heavy traffic street. For light traffic it has been laid with success on grades up to 12 per cent. It is an established fact that this type is most slippery on light grades, say under 2 per cent., during bad weather conditions, when the surface is covered with a thin film of slimy mud, with insufficient rainwater and grade to cause self-cleansing.

VIEW OF MULBERRY STREET WEST OF HOWARD STREET, BALTIMORE, MD.
Paved with Sheet Asphalt on 6 in. Concrete Base with Brick Gutters. Completed in 1914.

If, after a proper application of the above factors and bearing in mind the limits of endurance, sheet asphalt is decided upon as the pavement to install, we must then consider the design, which procedure is about as follows:

Base

A bituminous pavement has little, if any, inherent strength, therefore, we must depend upon its base, the character and thickness of which must be selected with care, depending mostly on the character and volume of traffic but also largely on the character and dependability of the sub-grade. Various kinds of base or foundation have been used; old pavements such as cobble, brick and granite block in place, have been used as such, by simply adding the binder and wearing surface. Practical experience has proven that this is not first class construction, although it has been completely successful in many instances. Its success depends entirely on the condition of the old pavement used as a base when the top is installed and extreme care must be used in all phases of the construction. Old macadam, well compacted from years of traffic, makes a very suitable foundation for this type of pavement when traffic is medium and fast moving, as on state roads not main arteries, and also on residential streets, but the same precautions must be taken.

The most desirable and the most dependable foundation for all pavements is concrete of a 1-3-6 mixture and from 4 to 8 ins. in thickness, depending on traffic and soil conditions, 6 in. being the usual standard. The subgrade should be finished to exact section and thoroughly drained and compacted before the foundation is laid.

Binder

The writer still adheres to the old-fashioned notion that a binder course is necessary and desirable for the following reasons:

A. The top of the concrete should be rough and is often uneven. The binder evens this up so that the wearing or top course can be of a uniform thickness.

B. It acts as a cushion between top and base, thus protecting to some degree at least, the top from the impact.

C. It protects, to a very large extent, the top from dampness, which in some soil comes up through the base.

D. It acts as a bond between top and base, thus preventing "moving" or "shoving."

Other reasons can be given for its use but these are the principal ones.

The standard thickness of the binder course is us-

ually 1½ ins. and it can be "open" or "close"; most engineers prefer it moderately close complying with specifications about as follows:

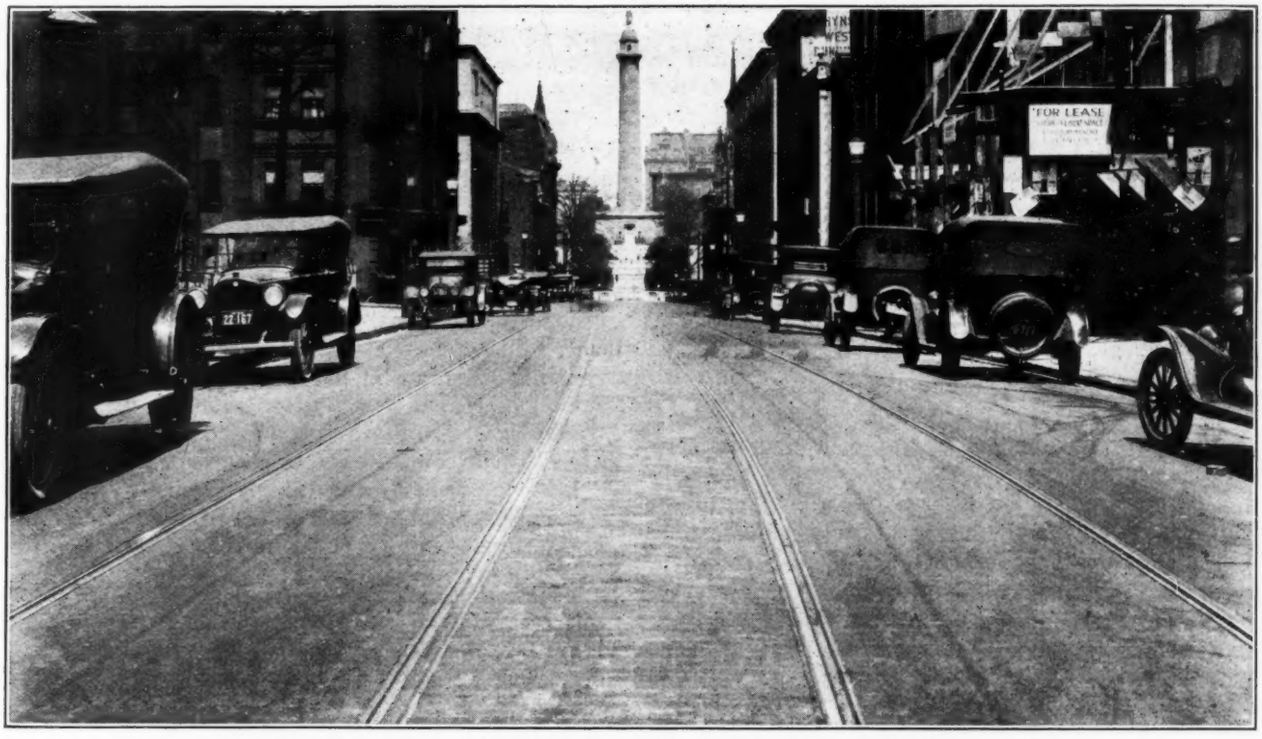
> The binder stone shall be hard, clean stone, free from any particles that have been weathered or are soft, all of which shall pass a 1 in. screen; 85 per cent. of the stone shall pass this screen in its longest dimension, and of the remaining 15 per cent., no piece shall have a larger dimension than 1¼ in. At least 65 per cent. of the stone passing the 1 in. screen to be graded in size from ⅞ in. to ⅜ in. and after passing the heating drum, shall contain not less than 15 per cent. nor more than 30 per cent. passing a ten-mesh sieve, so as to produce after the asphalt is added and then laid, a binder that in the judgment of the chief engineer will be a compact mass with a uniformity of voids, and that is suitable for the street on which it is to be laid.

The percentage of bitumen should be regulated in accordance with the mesh, composition and character of the stone aggregate, the minimum amount being 4½ per cent., but in any event sufficient to hold the particles of aggregate together. Soft or fat spots should be avoided. The binder should come to the work sufficiently heated, so that it can be spread, raked and rolled to a solid, uniform surface, parallel with, and the thickness of the top course below, the finished surface.

Top or Wearing Course

As stated, elsewhere, the wearing surface is composed of carefully graded sands and fine mineral filler, such as limestone dust or Portland cement, with sufficient asphaltic cement added to hold the particles together. The mineral aggregates really carry the traffic, the asphaltic cement simply acting as a binder to hold them together. The selection of both, however, is important, as upon these will depend the utility of the pavement if it is really to perform the functions for which it is intended. Ideal sands are frequently very difficult to obtain in some localities. Washed sand is preferred to bank sand because the latter so often contains small quantities of loam which will "ball" and weaken the mixture. One often has to take several sands and mix them before a satisfactory mesh composition can be obtained but a typical grading is given below, taken from Brochure No. 11 of the Asphalt Association:

Characteristics Mineral Aggregate	Class 4 Light Traffic	Class 4 Heavy Traffic
	Per Cent. of Mineral Aggregate	
Passing 10 mesh retained on 20 mesh	8	3
Passing 20 mesh retained on 30 mesh	10	5
Passing 30 mesh retained on 40 mesh	12	8
Passing 40 mesh retained on 50 mesh	15	14
Passing 50 mesh retained on 80 mesh	27	26
Passing 80 mesh retained on 100 mesh	9	15
Passing 100 mesh retained on 200 mesh	10	14
Passing 200 mesh	9	15
Total	100	100
Per Cent. of Bitumen in Mixture	10	11



VIEW OF CHARLES STREET NORTH OF MULBERRY STREET, BALTIMORE, MD.
Paved with Sheet Asphalt on Sides on 6 in. Concrete Base. Vitrified Block in Tracks with Wood Block Liners between Asphalt and Rails. Completed in 1915.

The amount of bitumen or asphaltic cement depends on the amount of traffic and the sand grading; the finer the sand the more asphaltic cement, as there are more surfaces in the aggregate to coat. No set rule can be followed; one must study the local sands available, analyze and if necessary mix them so as to bring the finished mix, if possible, within the bounds of good practice.

Penetration

The penetration of the asphaltic cement is very important, and recent practice shows an inclination to use a lower penetration than formerly as the addition of oil drippings from motor traffic shows a tendency to soften the surface. Therefore, by lowering the penetration when the pavement is constructed, the subsequent addi-

tion of oils from that source will bring the consistency to about the desired point, and prevent what otherwise would cause "moving" or "shoving."

The following is a typical penetration grading, copied also from the Asphalt Association Brochure No. 11:

Characteristics Asphalt Cement		Light Traffic	Heavy Traffic
Traffic	Climatic Temperature	Penetration at 77° Fahr.	
Light	Low	55	..
	High	45	..
Heavy	Low	..	45
	High	..	40

It is also very important that the wearing surface reach the street heated to such a degree that it can be readily raked and rolled to produce a compact, smooth surface of uniform thickness.

Inspection

It is necessary to have expert, but practical inspection, both at the plant and on the street. Many highway departments maintain a laboratory in connection with the inspection system, so arranged that samples from both plant and street can be analyzed and checked one against the other. With a proper system of inspection, poor materials and workmanship can be avoided and it can be determined, within a very short period, whether or not the work is being executed in accordance with the contract and specifications. Such a system can be made very valuable to both principals.

Gutters of Vitrified Block

Gutters of some hard, durable material, such as vitrified block, are desirable and at times absolutely necessary, particularly where there is any amount of surface drainage. Where all surface drainage has been eliminated they are necessary on grades under 2 per cent., but they are desirable on all bituminous construction for two reasons:

Gutters are for the purpose of collecting drainage and consequently the space next to the curb is generally damp, particularly on flat grades, owing to the collection of debris, etc. Furthermore, it is not always feasible to roll in close proximity to curbs and the existence of a gutter 12 to 18 in. in width permits a more accurate cross section and contour, and also permits the accomplishment of better compression and more expert handling of the roller.

Railway

More failures in bituminous construction occur adjacent to the tracks than anywhere else, due to concentration of traffic within the track areas, but more generally to poor track construction. Therefore, the railway construction should be of the best rails of the latest pattern, on sound ties, brought to good line and surface. Ties should be on a foundation of either rock ballast or concrete. Where the paved drive is of sufficient width as not to cause concentration of traffic, bituminous pavement can be laid within the track area, in which case liners of hard material such as granite should be laid against the rails. This also permits access to joints in case repairs are necessary. In case there is a decided concentration of traffic, the track area between extreme outer rails should be paved with some hard material such as granite or vitrified blocks.

ASPHALT CEMENT QUALITIES AND TESTS NEEDED IN SPECIFICATIONS FOR SHEET ASPHALT AND ASPHALTIC CONCRETE PAVEMENTS

By J. W. Howard, C. E., E. M., Consulting and Testing Engineer of Pavements and Roads, 1 Broadway, New York, N. Y.

Many city, county and state engineers, and paving contractors, desire to know the qualities an asphalt cement must have and the laboratory tests it must meet, to be good and reliable for use in making sheet-asphalt and asphalt-concrete pavements; without respect to brand name or the crude or raw materials from which it is manufactured.

Just as the qualities and tests for good Portland cement are now well established, so are those for good asphalt cement for use in compounding hot paving mixtures for sheet-asphalt and for asphalt-concrete wearing surface layers to go on the various kinds of good pavement bases or foundations; sheet-asphalt being generally made of suitable sand, powdered limestone filler and asphalt-cement; asphalt concrete being of the same three ingredients, with suitable crushed stone added.

The following is based on a practical experience of 30 years in laying, and making laboratory tests of pavements and pavement materials; before, during and after successful use:

First. It is best to state the basic qualities good asphalt-cement must possess, because it is this cement which goes into a pavement mixture and not the separate or single raw material from which an asphalt cement is made. All asphalt cements are artificial products, either by refining separate materials and mixing them, or by distilling or refining a raw or crude material.

The basic qualities of every asphalt-cement for hot-mixed asphalt composition pavements are:

1. Adhesiveness or cementing strength.
2. Waterproofness or freedom from injury by water.
3. Immutability, or freedom from deterioration from exposure to sun and air.
4. Cohesiveness.
5. Ductility.
6. Flexibility or pliability.
7. Malleability or yielding to shock without cracking.
8. Consistency or softness (penetration) at mean weather temperature (77 F.), proper for the kind of pavement, traffic and climate.
9. Minimum allowable susceptibility to softening or stiffening from extreme weather temperatures.
10. Purity or high percentage of bitumen or cementing ingredient.
11 Freedom from impurities of vegetable or other deleterious matter.
12. Freedom from injury by the degrees of heat necessary from melting and use in making pavement compositions or mixtures.

Second. While the above are the basic qualities the asphalt cement must possess, the following are the chemical and physical tests which the author makes in his laboratory to determine if any asphalt cement, without respect to brand or method of manufacture, is fully suitable for use in making any asphalt pavement coming

within the two types named; sheet-asphalt and asphalt-concrete, within each of which there are several kinds.

The tests of asphalt-cement, which can be safely incorporated in specifications for (hot mixed) sheet-asphalt, including its binder-course and asphalt-concrete pavements, are as follows:

The asphalt-cement used in the pavement shall have the following qualities and meet the following tests:

(a) It must contain no water, coal or gas tar or their derivitives.

(b) It must be homogeneous and uniform.

(c) It must not be affected by water or contain any substance soluble in water, and thus be waterproof. The test for waterproofness is to put a very thin hot coating or film on a clean, dry glass plate and immerse one-half of the plate and film in clean water in a covered jar for two or three weeks and then observe, by withdrawing the plate, if the immersed portion of the asphalt-cement, compared with the non-immersed, dry part, has become grey or softened or injured by the water.

(d) It must be ductile to the extent that at 77 degrees F. it can be stretched at least 40 centimeters; after having been formed in a mould so that its central cross section is 1 square centimeter, as per specifications of Washington, D. C., New York, etc.

(e) Its specific gravity at 77 degrees F. must be at least 1.01.

(f) Its penetration, or degree of softness, at 77 degrees F. must be between 35 (0.35cm.) and 75 (0.75cm.), according to the other materials used in the pavement mixture, the climate and weight of traffic and as directed for each pavement and street or road; low penetration for warm and high penetration for cold climates; low for heavy and higher for light traffic; higher penetrations for asphalt-concrete than for sheet-asphalt pavements. The test for penetration is to be made with any proper penetration apparatus; using a standarized No. 2 needle, under 200 grams weight for 5 seconds, measuring the depth of penetration of the needle into the asphalt-cement.

(g) Its freedom from volatile oil and safety for heating for use must be tested by the flash test, made with the asphalt-cement in a metal or porcelain crucible about 3 ins. in diameter across the top and about 1½ ins. deep, with the thermometer bulb in the melted asphalt-cement. The flash test is when a slight flash of fire, with a slight popping noise, occurs on the surface of the slowly heated asphalt-cement, when a small flame or lighted match is applied. The temperature at which the asphalt-cement flashes must not be below 450 degrees F.

(h) Its stability against injury by heat in use and by weather action on the pavement is determined by exposing 20 grams in an open tin can between 2 and 2½ ins. diameter, 1 to 1¼ ins. deep, exactly 5 hours, in hot oven air, at 325 degrees F., and the asphalt-cement must not lose more than 3 per cent. of its original weight.

(i) The penetration or degree of softness of the residue at 77 degrees F., after test (h), must be at least 60 per cent. of its original penetration (test f); that is test (h) must not harden it more than 40 per cent.

(j) At least 98 per cent. of the pure bitumen of the asphalt-cement must be soluble in carbon tetrachloride at about 77 degrees F., or room temperature.

(Note. The bitumen (or purity) of the asphalt-cement, is the portion by weight soluble carbon bisulphide. It ranges from about 70 per cent. to 99.9 per cent. in good asphalt cements, meeting all the tests of these specifications.)

(k) The purity or pure bitumen content of the asphalt-cement used in any one pavement, as determined by solubility in carbon bisulphide, must be uniform and not vary more than ½ of 1 per cent. up or down.

(l) The asphalt-cement must have an average cementing strength (three tests) of at least 25 lbs. per sq. in. (Howard or equivalent method), when made into a hot compressed briquette composed of standard Ottawa sand (of 20-30 mesh size grains), 90 parts by weight and 10 parts of the approximately pure bitumen of the asphalt-cement (or asphalt cement itself when above 99 per cent. pure bitumen). These briquettes have the same shape and size as the standard Portland cement briquettes of the American Society of Civil Engineers and must be broken by tension at 77 degrees F. in any briquette cement-testing apparatus used for Portland cement tensile tests.

Where the specifications contain the above twelve tests, and no requirements under the guise of tests are added to identify, limit or wrongly favor special brands, and where the twelve proper tests are applied during use of an asphalt-cement, then good pavement, as far as the asphalt-cement is concerned, will result.

No asphalt pavement has been condemned for failure of the asphalt-cement where records show that the above tests were met. It must be remembered that asphalt-cement is only from about 8 to 11 per cent. of asphalt pavement compositions. Care must also be used to test and use proper gradation of the mineral aggregates. Over heating, lack of compression, laying too cold, open or porous binder layer instead of dense or close binder (under asphalt pavement surface layer), lack of good foundation, etc., all these are causes of failures and must be avoided in order to secure good, durable asphalt pavements of all types.

THE REVIVING INTEREST IN INLAND WATERWAYS

By W. J. Sherman, Consulting Engineer, 618 The Nasby, Toledo, Ohio.

How often do we hear that the American railway system has completely broken down? Claiming that the fault lay with the owners, the Federal government, early in the war, took over the railways during the emergency period.

Government operation was a colossal failure and the most ardent champion of government ownership now seems willing to admit it.

Back in the hands of the owners the railways are still unable to meet the transportation demand. It is not the purpose of the writer to discuss the causes of the failure of the American railways to function properly when most needed. But in passing we should perhaps call attention to the fact that prior to the world war the railways were not permitted to earn enough to provide sufficient equipment, suitable terminals, and at the same time maintain themselves in a good physical condition.

Under government management conditions were worse and employes far less efficient, while the business offered the railways was much greater than normal.

Back once more in the hands of their owners, with physical condition greatly impaired, and the morale of the operating force much below normal, it is universally conceded that the railways cannot meet the demands upon them and supply the transportation which the country requires. Meanwhile, the volume of business seems to be constantly on the increase, the products of the factories must be moved, and the supply of raw materials must be replenished.

Motor trucks and public highway transportation are requisitioned in a vain effort to relieve the congestion. The highways built for light traffic break down under the ponderous motor trucks. The great centers are congested as never before. Ships are waiting for fuel, cargo release or new cargoes in all the ports of the Atlantic and the Great Lakes.

What is the solution of the problem? Some of the best minds of the country are giving attention to this most important subject.

Waterways Are Coming Back

There was a time when inland waterways were in good commercial standing. This was before the time of the railways. Perhaps the golden era of inland waterway prosperity may be said to include the first half of the nineteenth century.

Then came that most wonderful and rapid development of the railway system and the inland waterway traffic began to decay.

Today the indications point to a great revival of interest in water transportation.

The rise and fall of the American Merchant Marine is coincident with the rise and fall of the artificial waterways in the interior of the country.

The revival of the former in accordance with the magnificent program of the Federal government, is turning attention to the wonderful possibilities of the latter.

Important Waterway Projects

Already much has been accomplished. Private capital has constructed the Cape Cod Ship Canal at a cost of twelve million dollars. State capital to the extent of one hundred and fifty million dollars has been provided for the construction of the New York State Barge Canal. Abundant government capital is available for canalizing the Ohio river for a 9 ft. minimum channel from Pittsburgh to Cairo, and already two-thirds of this mammoth undertaking has been accomplished.

The state of Illinois has appropriated twenty-million dollars for the improvement of the Illinois river and the completion of an all-water route between Lake Michigan and the Mississippi river. This will provide a suitable connection between the 15,000 miles of navigable channel in the Mississippi Valley, and the 2,500 miles of navigable waters of the Great Lakes.

Other connecting links are considered, including the Barge Canal across the state of Ohio, between Lake Erie and the Ohio river, over one of the several competing routes, and a Barge Canal from Lake Erie to Lake Michigan via the Maumee river and the city of Fort Wayne.

New Orleans is Alert

New Orleans, awake to the revival of river traffic, is expending fifteen million dollars in port improvements, hoping and expecting to provide a suitable outlet for the products of the Mississippi valley, which New York, struggling against congestion and unfavorable labor conditions cannot do.

One of the greatest waterway projects under way at the present time, is that which has for its object the improvement of the St. Lawrence river at international expense, so that ocean-going vessels may enter the Great Lakes.

The St. Lawrence River Project

The importance of this project has been officially recognized by both Canada and the United States, and a joint commission is now engaged in the preparation of a report with recommendation and estimates of cost.

We believe it is safe to prophesy a favorable report from this commission, notwithstanding the bitter opposition of New York and Montreal, for purely selfish reasons.

The commercial interests of 27 states of the middle West are receiving the fostering care of the Mississippi Valley Association. The friendly attitude of this association towards water transportation and the St. Lawrence project, is shown in the following resolutions adopted at their recent convention:

Merchant Marine

We declare for the completion of a well balanced Merchant Marine. We believe in American shipping carried on American bottoms, under the American flag, the ships manned by American sailors. Nothing short of the establishment of such a policy will satisfy the Mississippi valley. The existing Legislative restrictions controlling the operation of American ships, should be modified to permit competitive operation with foreign ownership.

Waterway Development

We commend the general policy of waterway improvement, especially on projects investigated and approved, the preservation of our interior waterways, lake and sea ports, and the construction of canals for commerce representing the very highest development of the country. We insist upon the fullest utilization of natural resources and the development of such resources that lend themselves to final success. Old world competition will demand such cheap transportation as a matter of self-protection. It is advisable that we urge the adoption of the principle of through water and rail rates.

Inland Waterways

We earnestly declare that the next Republican National Convention, and the next Democratic National Convention, be urged to adopt planks in their platforms favoring the development and the speedy completion by the national government, of the various inland waterway projects, approved by the engineers of the war department.

St. Lawrence Canal

We earnestly favor the prompt improvement, by the joint action of the United States and Canadian governments, of the St. Lawrence river so as to admit ocean-going vessels to the Great Lakes; also

the development of the hydro-electric power incident thereto. This improvement making sea ports of our lake ports would double the value of our internal waterways and the whole would go far toward prompt and effective relief from the transportation deadlock under which the central portion of our country now suffers.

Not until the true story of the world's war is told will we realize the important fact played by the network of European canal water courses in the conduct of the war.

In the opinion of the writer the day is not far distant when there will have been developed a grat American system of inland waterways, which is comparable in its importance to the European system which is in operation today.

ESTIMATING LABOR HOUR REQUIREMENTS FOR THREE TYPES OF STREET RAILWAY TRACK CONSTRUCTION

By D. B. Davis, City Civil Engineer, City Hall, Richmond, Ind.

To secure accurate estimates of cost for street railway track construction it is necessary to know the labor hour requirements for executing the different divisions of work.

Generally in single track construction, when the excavation is completed and the subgrade compressed until it is smooth and hard, the ties are distributed and spaced 24 ins. c. to c. upon the sub-grade and the rails spiked thereto. The track, after being lined and leveled, is securely blocked to prevent any displacement by the working force. Then concrete of a wet consistency is mixed and deposited around the ties and brought to within 6 ins. of the top of the rail.

Using a boom and bucket one-bag mixer, when the gravel has been deposited in the proper amount along the site of the work, the following organization will lay on an average of 220 lin. ft. in 10 hours, or it will require 0.40 labor hours per lineal foot.

The organization for concrete base is: 1 engineer mixer, 1 fireman mixer, 1 concrete spreader, 1 handling cement to mixer and 5 shoveling gravel in mixer. Fig. 1

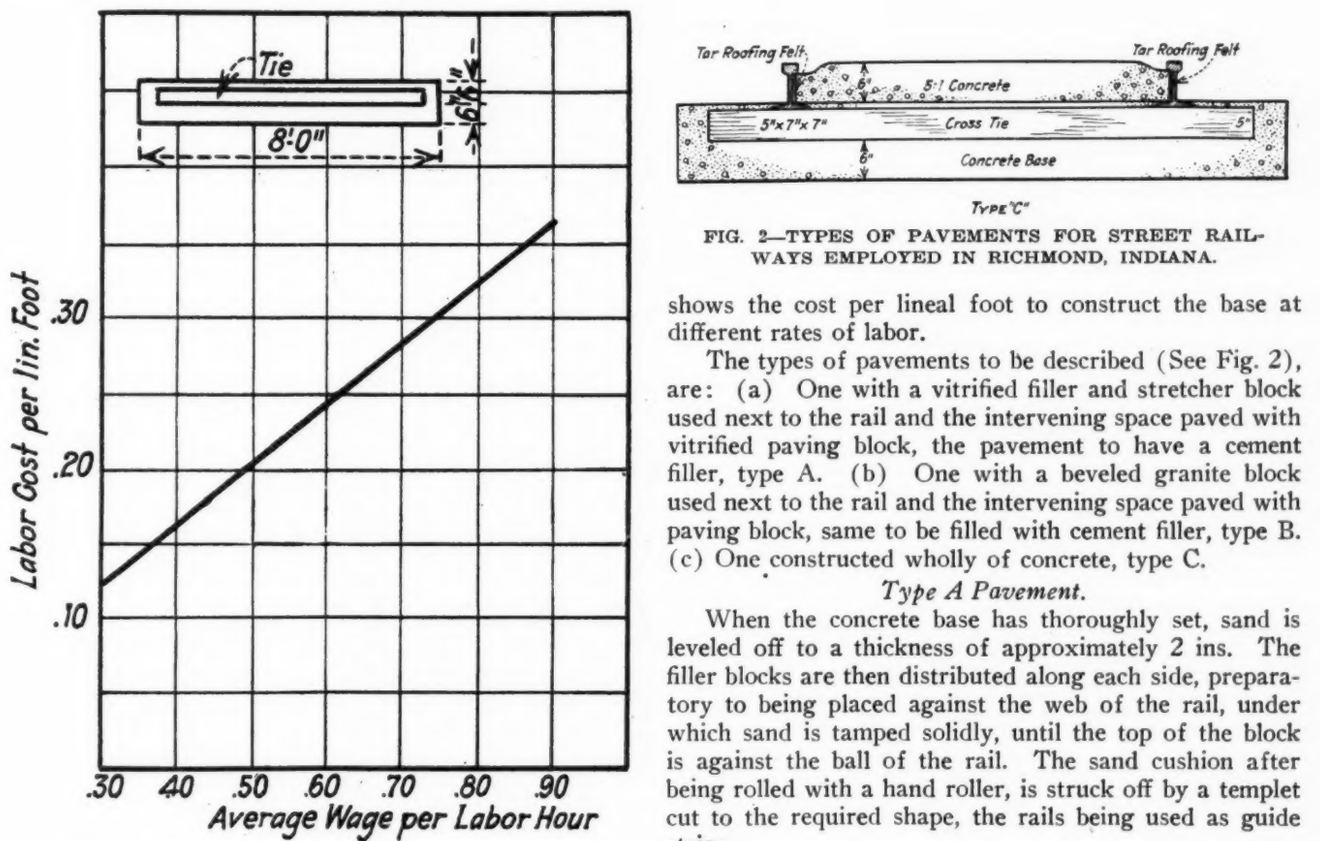


FIG. 1—COST PER LINEAL FOOT TO CONSTRUCT CONCRETE BASE FOR STREET RAILWAY TRACK AT DIFFERENT RATES OF LABOR ASSUMPTION: 0.40 LABOR HOURS PER LIN. FT.

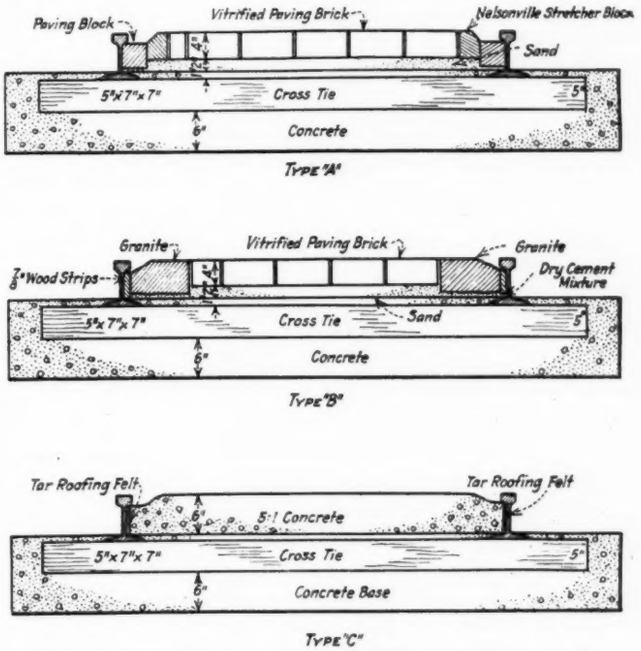


FIG. 2—TYPES OF PAVEMENTS FOR STREET RAILWAYS EMPLOYED IN RICHMOND, INDIANA.

shows the cost per lineal foot to construct the base at different rates of labor.

The types of pavements to be described (See Fig. 2), are: (a) One with a vitrified filler and stretcher block used next to the rail and the intervening space paved with vitrified paving block, the pavement to have a cement filler, type A. (b) One with a beveled granite block used next to the rail and the intervening space paved with paving block, same to be filled with cement filler, type B. (c) One constructed wholly of concrete, type C.

Type A Pavement.

When the concrete base has thoroughly set, sand is leveled off to a thickness of approximately 2 ins. The filler blocks are then distributed along each side, preparatory to being placed against the web of the rail, under which sand is tamped solidly, until the top of the block is against the ball of the rail. The sand cushion after being rolled with a hand roller, is struck off by a templet cut to the required shape, the rails being used as guide strips.

Stretcher block, made by the Nelsonville Sewer Pipe Co., were then set against the filler block, which had been previously laid. The intervening space was then laid and

batted in with vitrified paving block. The defective brick having been removed and good ones put in their place, and the track swept clean of spalls and dirt, the brick were tamped until a smooth surface was attained. The filler, composed of one part Portland cement to one part

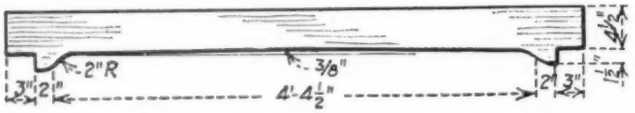


FIG. 3—TEMPLATE USED IN GRADING CONCRETE PAVING BETWEEN RAILS OF STREET CAR TRACK.

clean sand, mixed to a consistency of thin cream, was applied to the pavement by scoop shovels and swept into the joints with brushes.

For this type of pavement it required the following labor hours:

To make sand cushion, set filler and stretcher block and lay and tamp brick in intervening space .....0.264 hrs.
Grouting entire space between rails with cement .....0.048 hrs.

Total labor hours per lineal foot to pave track...0.312 hrs.

Type B Pavement.

The concrete base was constructed as in type A, and the sand was spread in the same manner as before stated. A 7/8 in. wood strip, 4 in. wide, was put against the web of the rail. Then a beveled granite block, measuring about 12 ins. long, 9 ins. wide and 5 ins. thick, was set in a dry mixture of cement and sand, of the proportion of 1 to 3, level with the top of the rail. Special care was taken properly to bed these blocks. The sand was spread and rolled, then cut off to grade by a templet pulled over the rails, a notch having been cut out of the templet to allow it to pass over the block. The space between was then paved, culled and tamped and the filler applied.

For this type of construction it required the following labor hours:

To set and bed granite block.....0.155 hrs.
To make sand cushion and lay brick in intervening space ready for cement grout.....0.166 hrs.
Grouting entire space between rails.....0.060 hrs.

Total labor hours per lineal foot to pave track..0.381 hrs.

Type C Pavement.

In this type of construction the concrete base was swept with brooms as clean as possible and all dirt scraped from the rails. An expansion joint consisting of 4 thicknesses of heavy tar roofing felt was placed against the web of each rail.

Concrete of the proportion of one part Portland cement to five parts clean gravel was mixed to a rather wet consistency and spread upon the concrete base, it being tamped with the back of a shovel to give it a maximum density.

A templet, as shown by Fig. 3, was drawn over the rails until the surface of the concrete was to a uniform grade, free from holes and conforming to the shape of the templet. When sufficiently hard the surface was then gone over lightly with a wooden float until it was comparatively smooth.

For this type of pavement it required the following labor hours:

To mix the concrete in a one-bag boom and bucket mixer, place it on the concrete base and finish it, required per lineal ft.....0.24 hrs.

Fig. 4 shows the cost per lineal foot to construct the three types of paving between the rails for a single track at various rates of labor.

The labor hours required for these various operations were obtained from the writer's experience in Richmond, Ind., and represent work that has been done by energetic, enthusiastic workmen. The proximity which another gang could approach these values would depend wholly on the morale of the workmen and the experience and "pep" of the man in charge.

FEATURES OF ANNUAL CONVENTION OF AMERICAN ASSOCIATION OF ENGINEERS

The outstanding sentiment of the delegates and other members attending the sixth annual convention of the American Association of Engineers, in St. Louis, May 10 and 11, was a desire for building up strong chapters of the association and for decentralization of some of the business functions. It is clear that one great necessity

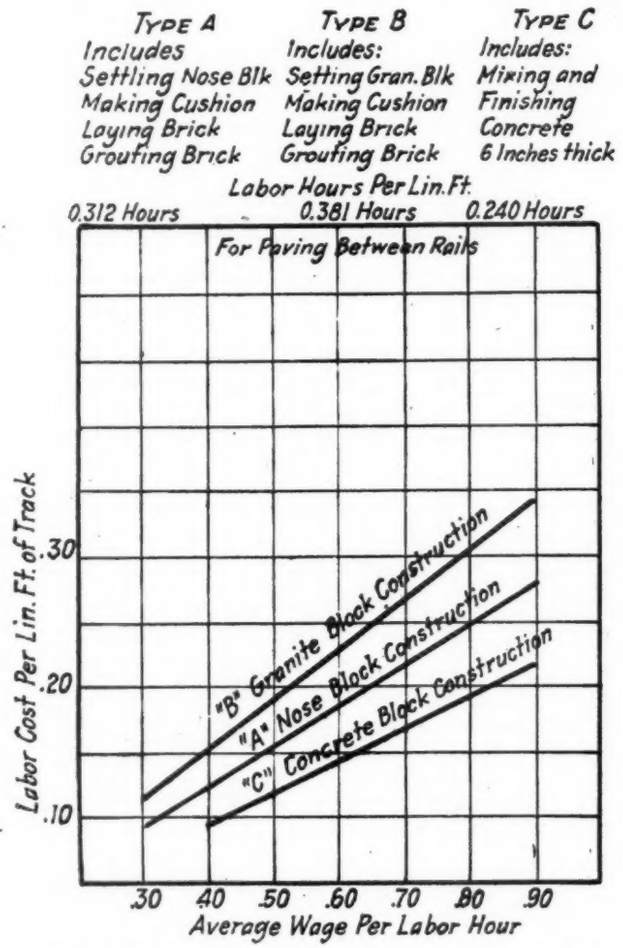


FIG. 4—DIAGRAM SHOWING THE COST PER LINEAL FOOT TO CONSTRUCT THE THREE TYPES OF PAVING BETWEEN STREET CAR RAILS, AS SHOWN IN FIG. 2, FOR SINGLE TRACK, AT VARIOUS RATES OF LABOR.

in an association of engineers is the direct responsibility of its constituents in its conduct.

The chapters are anxious to take over some of the work that has been formerly done at national headquarters, such as passing on qualifications of applicants and collecting dues. The chapters feel the need for building their organizations up into powerful local organizations and strong representatives of the national association.

Association Building.

The decision to appoint a board of trustees to consider acquiring a national engineering building in Chicago was the first business transacted by this sixth annual convention of the American Association of Engineers, which now has over 17,000 members. The building program will be formulated by the Board of Trustees and formally approved later by the Board of Directors. It was announced that the City Hall Square Building in Chicago might be purchased.

The same Board of Trustees will also consider the proposition of providing group insurance for members of the association, in accordance with a resolution introduced by Garrison Babcock, a consulting telephone engineer of Chicago.

Salaries of Engineering Teachers.

Salaries of teachers in engineering colleges in the United States were recommended tentatively by A. N. Johnson, consulting highway engineer of the Portland Cement Association of Chicago, and Daniel L. Turner, chief engineer of the Transit Construction Commission of New York City, reporting for the committee on salaries of engineers in teaching service, of which Prof. C. J. Tilden of Yale University, is chairman. The dean of an engineering college is recommend for a salary of from $8,000 to $15,000 per annum, depending on the size of the college; professors, $5,000 to $12,000; associate professor, $4,000 to $9,000; assistant professor, $3,600 to $7,500; instructor, $3,000 to $4,000; assistant instructor, $1,800 to $2,400.

Unionism in the Profession.

Unionism in the engineering profession was strongly condemned in a resolution endorsing a statement issued by the Board of Directors of the association, reading in part as follows.: "We believe in organized representation for the correction of wrong, the advancement of the engineering profession, and service to the public, but are opposed to methods inconsistent with the dignity of the profession and which would lessen public confidence in engineers. The American Association of Engineers, recognizing the many fundamental differences between the principles and objectives of the trade union and an organization of professional men, expresses the opinion that an engineer can not subscribe to the tenets of both." The resolution recommended the expulsion from the association of engineers those who advocate strikes or similar methods of securing their ends.

Resolutions.

The association also decided to ask candidates for the presidency to declare themselves for or against the proposed national department of public works, for or against a national budget, for or against a constructive program of conservation of natural resources, and for or against reclamation of waste lands.

Another resolution declared that "adequate highway transportation is a prime requisite for the proper development of all sections of our country," and urged encouragement of worthy highway projects and the continuation of appropriations by congress as federal aid.

The immediate restriction of the exportation of such natural products as petroleum and its products, wood and wood-pulp, paper, etc., will be urged upon congress as a means of conserving the natural resources of the country.

"One of the most important means of stabilizing conditions and values lies in greater individual application and industry," read another resolution, and it was enthusiastically adopted, with a pledge that each member would direct his efforts toward the end aimed at by the resolution.

The scheme of Secretary of Agriculture Meredith for the utilization of timber reserves of Alaska for the manufacture of wood-pulp for paper was endorsed as a feasible method of reducing the shortage of print and other paper. The association pledged itself to aid in this project in every way possible.

The legislature of Delaware was urged to adopt the suffrage amendment to the federal constitution.

To establish the supremacy of the United States in airship development, a resolution was adopted urging congress to enact legislation authorizing federal development of aircraft on a large scale, or the construction of aircraft by subsidizing commercial organizations.

Officers Elected.

The following officers of the association were elected for the present year: President, L. K. Sherman, president of the U. S. Housing Corporation of Washington; Vice Presidents, H. O. Garman, chief engineer of the Public Service Commission of Indiana, Indianapolis, and A. B. McDaniel, principal engineer of the construction division of the army, Washington; Directors, Edmund T. Perkins, consulting drainage engineer of Chicago, Charles A. Finley, managing engineer of the water bureau of the city of Pittsburgh, W. C. Bolin, an engineer with the Baltimore & Ohio Railroad of Chicago, B. A.Bertenshaw, valuation engineer of the Big Four Railroad, Cincinnati; Prof. Frederic Bass of the University of Minnesota, Minneapolis, and R. W. Barnes, principal assistant engineer of the Southern Pacific Railroad, Portland, Ore. Retiring President F. H. Newell, head of the department of civil engineering in the University of Illinois becomes a member of the board of directors automatically. The following directors hold over another year: Raymond Burnham, consulting engineer of Chicago; E. F. Collins, civil engineer of St. Louis; P. E. Harroun, consulting engineer of San Francisco; A. A. Matthews, chief engineer of the St. Louis and Southwestern Railroad, and F. D. Richards, consulting engineer of Cleveland, O.

The 1921 convention will be held in Buffalo, N. Y.

HISTORY OF WARRENITE—BITULITHIC ROADS AND PAVEMENTS AND SOME NEW DISCOVERIES IN PAVEMENT CONSTRUCTION

By George C. Warren, President Warren Brothers Company, 142 Berkeley St., Boston, Mass., in Addressing Class in Highway Engineering at Valparaiso (Ind.) University, May 14, 1920.

Early in the year 1901 the, then entirely novel, construction which has developed into Warrenite-Bitulithic was first brought to the attention of your instructor, Professor Charles Carroll Brown, then editor of "Municipal Engineering" (now Municipal and County Engineering), by its inventor and the writer's brother, the late Frederick John Warren. It was then little more than a collection of embryonic thought in the inventor's mind, engendered by 15 years' practical experience in the refining of asphalt and other bituminous materials, and in the laying of asphalt pavements, and 2 years' constant laboratory work in development of the new idea.

Fundamental Idea.

Fundamentally, this idea was that better and more durable bituminous pavements than those in previous use could be produced by scientific grading of comparatively coarse grain mineral aggregate (either gravel or crushed stone) combined with high grade asphaltic materials. Briefly, the principle of the grading of the aggregate, which was in the inventor's mind from his first study of the matter, was to make the compressed aggregate as dense as possible and coating the particles of aggregate, preferably heated, with specially prepared high grade asphaltic cement, the result being true asphaltic concrete, practically as dense and voidless as solid stone. This density is produced by combining particles of aggregate, ranging from the largest to impalpable powder, in such proportions that each receding size of aggregate is sufficient in quantity to fill the voids between the coarser sizes. With some surprise it was discovered that uniform sized grains of any given size contain the same percentage of voids or air space, these voids being approximately 50 per cent. of the bulk of the compressed aggregate of such uniform size. In other words, a block or piece of stone broken into pieces of uniform size, produces a bulk double that of the solid rock. In crushing, therefore, a cubic yard of ledge rock is increased in volume to 2 cu. yds. of closely screened uniform sized product, each separate uniform size containing approximately 50 per cent. voids. This is true whether 2 in. or larger size, or as fine as one two-hundredth inch or even smaller, in which the individual voids are so small that they can not be seen by the eye.

The first problem which presented itself to the inventor was to devise means of determining the proportions of varying sized grains, which would reduce the voids to a minimum and apparatus to make tests accurately and equipment to produce the result practically in large quantities. In these early experiments the inventor was assisted by August F. Schutte, chemist, and Horace W. Ash, mechanical engineer, both of whom are still associated with Warren Brothers Company.

Void Testing Apparatus.

Schutte invented the truncated cone for testing voids and determining proportions, it being found that all prior means of testing voids were quite inaccurate and unreliable. For instance, the old method of attempting to fill the voids with water only found a portion of them as the water did not expel the air from the smallest voids, which constitute a very large proportion of the total voids. Another method of shaking the material in a cubical box was also inaccurate because the more the box was shaken the more the fine material would sift to the bottom of the container and force the coarser particles upward to the point of "overflowing" the box. With the truncated cone having a base say 6 in. in diameter and top opening, say, half that diameter when the coarse particles of aggregate are shaken down, they are so wedged together and between the sloping sides of the cone, that power from below can not force them up. The cones were first made of heavy sheet copper soldered at the bottom and sides, but the pressure produced by shaking the aggregate was such that it bulged the cone at bottom and sides. It was found necessary to make the cone of steel as heavy as ⅛ in. securely riveted at bottom and sides. With this apparatus and violent shaking until no more material can be gotten into the cone, and by using the correct proportions of all grades of aggregate from coarsest to finest the 50 per cent. voids in the uniform-sized aggregate can be reduced to about 10 per cent. or to density within 10 per cent. of that of solid ledge rock. The cubical contents of the cone is known and the weight of compressed aggregate compared with the weight (determined by specific gravity) of a solid block of stone of the same cubical content and quality as being used for the test determines the percentage of voids. The results vary with varying shapes and sizes of each quality of aggregate, consequently the "void test" must be made in the laboratory in advance of pavement construction, using in the test the identical quality and sizes of aggregate to be used in the practical construction. With the voids thus determined the next step is to determine the quantity of bitumen, which is necessary to:

(a) Fill all the voids and a slight surplus.

(b) Thoroughly coat all the particles of aggregate with the asphaltic cement.

By these methods and practices and scientific laboratory control we are able regularly and practically to accomplish (what no other form of monolithic bituminous pavement, even approximately, accomplishes) to wit, compression of approximately 4 in. in depth of commercial ingredients into a compressed depth of 2 in.

From this brief description of the scientific rudiments it will be seen that the result is a highly scientific, true asphaltic concrete, having practically the density of solid rock.

Time, on this occasion, will not permit a description of the many other processes and forms of apparatus for testing both the ingredients used and the completed pavement, also the improved detail methods of construction, all of which service is furnished by highly equipped laboratories, with large forces of employes, one of which laboratories is located in Cambridge, Mass., and another in Portland, Ore., at each of which in the working season, approximately 100 complete tests are made daily, including daily samples from all of the approximately 200 places where Warrenite-Bitulithic roads are being simultaneously constructed during the busy season. Rudi-

mentary laboratory apparatus is also maintained at each operating plant. This is part of the very important service which Warren Brothers Company gives in conjunction with the use of its patents.

Equipment Invention.

Having overcome the difficulties of laboratory determination of ingredients to be used, the next difficulty was to devise equipment to produce, practically, the desired results as determined by laboratory operation. For this Horace W. Ash devised two general types of plants, which are diametrically opposite in their methods of accomplishing the same result, to-wit:

1. *Stationary, semi-portable; Portable Road and Railroad plant types* in which the aggregate first passes through rotary heaters in approximately the desired proportion; then is separated into several sizes by a sectional rotary screen of sufficient length and diameter to provide perfect separation; each size is kept separate in a sectional bin; accurately weighed in a box resting on a multi-beam scale and delivered to a "twin-pug" mixer, in which the hot bitulithic (asphaltic) cement is added.

2. *Portable plant type* for which the several sizes of aggregate are accurately measured, *before heating,* into a batch of certain weight; delivered into a rotary drier, heated by oil-burner flame; the batch held together as a unit and delivered into a rotary mixer, where the hot bitulithic cement is added. This type of plant, in one unit, is permanently mounted on its own wheels and can be drawn by steam roller or horses. It is therefore available for use either alongside railroad or in a quarry or gravel pit, or alongside a road being paved and is, therefore, most flexible in its operation.

It will be noted that each of these plant types is based on accurate proportioning of the several sizes of mineral aggregate into batches of certain size and each batch held as a seperate unit until thoroughly mixed with carefully weighed bitulithic cement and deposited in truck for hauling to the street.

Two hundred and twenty of these plants have been constructed and are regularly used throughout the United States and Canada. For construction of these plants very complete and extensivé plants have been developed in Cambridge, Mass., and Portland, Ore., having a combined annual capacity of about 45 plants.

Resulting Development.

In the fall of 1901, when the actual construction had been limited to experimental areas in the cities of Pawtucket, R. I.; New Bedford, Mass., and Cambridge, Mass., the inventor, Fred Warren, addressed the American Society of Municipal Improvements on the then novel construction. He was asked by the then president of the Board of Public Works of a prominent city, which has since laid over 1,000,000 sq. yds. of the pavement: "Don't you think you will know more about this construction after you have used it for five years?" The answer given was: "If we do not learn something and put it in practical use every day, I should say we will be a failure."

The result, including the public confidence which has been earned, is best shown by the following table of development of Warrenite-Bitulithic, which includes nearly every state and territory of the United States and province of Canada.

WARRENITE-BITULITHIC AREA LAID AND CONTRACTED FOR IN 20 YEARS

Year	Cities and Counties	Square Yards
1901	7	16,400
1902	33	400,831
1903	40	915,630
1904	45	1,041,724
1905	42	1,041,327
1906	57	1,508,095
1907	66	1,924,222
1908	62	1,676,433
1909	79	2,071,987
1910	102	3,047,276
1911	112	4,189,182
1912	180	4,830,601
1913	171	5,081,068
1914	149	4,204,943
1915	154	4,495,393
1916	177	5,519,765
1917	192	5,219,173
1918	165	4,799,783
1919	187	7,467,331
1920*	227	14,811,438
		74,262,602

Total equals 4,219 miles roadway, 30 ft. wide between curbs.

*Laid and under contract to May 1st.

Foundation.

Aside from improvements in the Warrenite-Bitulithic pavement surface, Warren Brothers Company has been progressive in the matter of foundation and has established the now quite generally accepted fact that tensile or beam strength is only one of the important considerations for a pavement base and that given a well-compacted, well-drained sub-base the factor of beam strength becomes less important than:

1. Resiliency.
2. Thorough uniting of surface to base.

These considerations have taken the specific forms of:

(a) Economic conservation of old macadam roads and old pavements and foundations of other types of pavement by regulating the grade and contour and surfacing them with the dense, stable, solid, standard Warrenite-Bitulithic surface. In cases where the old macadam is of insufficient depth, say 6 in. or more of solid road metal, it is reinforced by the addition of the required quantity of new stone spread and compressed over the old macadam.

(b) New compressed stone base.

(c) Dense bituminous concrete base.

During the past ten or more years these types of base have been practically used under such widely varying climatic and other conditions as to prove their economic utility beyond peradventure.

Gravel Aggregate.

Beginning in the city of Portland, Ore., ten years ago, clean, sound gravel has been used on the mineral aggregate of both Warrenite-Bitulithic surface and bituminous concrete base to such a general and vast extent as to prove it to be fully equal to the best crushed stone.

Such gravel has the advantage over crushed stone of greater toughness and on account of its shape and toughness much less liability to fracture and displacement under traffic when exposed at the surface.

The theoretical objection held at one time that the rounded particles of gravel would not become firmly held in the structure and liable to displacement is thoroughly exploded by ten years' practical experience under widely varying conditions.

Surface Improvements.

In the year 1910, Edwin C. Wallace, who has been associated with the speaker in paving organizations for more than 25 years, developed and patented the invention

that the different sizes of the mineral aggregate in the wearing surface of a bituminous street pavement, in addition to being properly proportioned should also be properly placed in their relation to each other, that is, with the coarser dense stable bituminous mixture at the bottom where the stability is most needed and the finer bituminous mixture near the surface, making the pavement densest at the top.

Patents granted him cover both an improved product and the method necessary to be used in making the product, which is a monolithic, bituminous concrete, pavement wearing surface, in which the coarse and finer mineral aggregate is so distributed throughout the mass that the product is a bituminous concrete structure, comprising "a rigid portion and a surface sealed to the elements."

This improved product is produced by first spreading upon the prepared foundation, a bituminous concrete mixture consisting of relatively coarse and finer sized particles of mineral aggregate, which have been previously thoroughly coated with bituminous cement, then immediately spreading thereupon, a relatively thin layer of a bituminous mixture, consisting of fine mineral aggregate and bituminous cement, and then compressing these two bituminous mixtures together by rolling, so that the latter fine mixture is forced into the interstices between the larger paricles of aggregate of the lower course. The compression by rolling being continued until the entire structure can be compacted no further and the result is a bituminous pavement wearing surface, the lower portion of which is composed of bituminous-coated large, medium and small sized particles of aggregate, so disposed as to impart stability and rigidity, and its upper surface composed of bituminous-coated fine particles of aggregate, thoroughly bonded and anchored into the lower portion by compression, thus producing "a compact and substantially integral mass, which is densest at the top." This construction protects the coarse aggregate from penetration of moisture, also from fracture and displacement of the coarse aggregate by a thin surfacing about ¼ in. of fine mixture, extremely rich in soft bitumen and, therefore, extremely waterproof and wear-resisting, at the same time maintaining the essential solidity and structural strength of the dense coarse aggregate wearing surface. Beginning with demonstration areas 10 years ago, this construction has come to be the universally accepted improved standard Warrenite-Bitulithic wearing surface, and has proved to have all the merit its inventor anticipated.

Asbestos-Bitulithic.

In the year 1916 Schutte applied for patent which was granted in 1918 for a pavement and method of laying it, using asbestos fibre combined with mineral aggregate, along certain scientifically determined lines.

Owing to difficulty in securing economic supply of asbestos under war and post-war conditions, the general introduction of this improved construction has been deferred, but sample demonstration areas have been laid during the past three years in several sections of the country, particularly under the rigorous climatic conditions of New England.

One commercial contract was executed in New Bedford, Mass., in the year 1919.

Enough work has been done and in use for a sufficient term to prove its practical utility. Of course the asbestos adds somewhat to the cost, but at normal prices for asbestos, this is fully compensated by its advantages.

The presence of the indestructible asbestos fibre adds toughness to and overcomes the brittleness of the asphaltic cement and wearing properties of the pavement structure, to which it imparts very remarkable and desirable qualities.

While the proportions of Bitulithic cement and varying sizes of aggregate employed in the Bitulithic surface are modified to meet the conditions imposed by the asbestos, none of the well established principles of the otherwise latest improved Bitulithic construction are in any way sacrificed or lost. The name given to the construction is "Asbestos-Bitulithic." It offers great promise for further meeting the requirements of modern traffic conditions.

Double Re-Flushcoating.

In every type of pavement the time comes when its surface becomes dry and roughened under traffic. In the case of bituminous pavements on the theory of "A stitch in time saves nine," a double re-flushcoating method, devised and patented by Wallace, affords a most economic method of renewing to its original vitality the old partially deteriorated surface.

Briefly stated, the process consists of:

1. Thoroughly cleaning the old surface.
2. Repairing holes and depressions, if any.
3. Painting the surface while clean and dry in warm weather with cold asphaltic paint, made of Bitulithic cement, liquefied by light solvent, called "Liquid Re-Flushcoating Bitumen," which is allowed to remain without further application for a few hours and until the liquid asphalt has well penetrated into the old surface and the volatile solvent has evaporated.
4. Give the surface a second painting of melted hot "Hard Re-Flushcoating Bitumen" of the proper consistency.
5. While the second coating of bitumen is still hot, spread and roll sand or crusher screenings.

The work requires only about a total of ¼ gal. per sq. yd. of the two grades of Re-Flushcoating Bitumen, which are supplied ready for use at per gallon prices, including license to use the patents and Warren Brothers Company service charges.

Other Improvements.

Several other important improvements are now in process of demonstration but, pursuant to the policy of Warren Brothers Company, nothing is said publicly of its improvements until they have been sufficiently tried in practical use to demonstrate their economic utility.

WATER POWER AND CONSERVATION

By H. de B. Parsons, Consulting Engineer, 22 William St. New York, N. Y.

In the past we have been lavish in the use and consumption of the many natural resources with which the United States was wonderfully endowed by nature and have given little heed to future requirements. Now that the nation's resources are becoming scarcer, we are awakening to their value; and appeals arise sporadically for some system in their use, for efficiency to restrict

needless waste, and for conservation which will protect the requirements of those to come after us.

Waste of Wood as an Example.

We certainly have not shown foresight in the use of wood. Trees were cut many feet above the ground, because it was cheaper to stand on the snow in winter, when the cutting was accomplished. The stumps were left to rot, although they contained many millions of board-feet.

The Forest Service of the U. S. Department of Agriculture reports that the total cut from the forests of the United States is about 21,800,000,000 cu. ft. per annum, while the total yearly growth probably does not exceed 8,000,000,000 cu. ft. Thus the estimated total cut for all purposes is more than 2½ times the growth.

Southern pine is rapidly disappearing and it is estimated that in 15 or 20 years the present production will be cut out and that the mills will have to seek small areas of virgin growth and areas of second growth. Again white pine, formerly extensively used in the arts and in construction, is so extremely scarce that it is no longer a factor in the lumber market.

At present many paper mills are operating in territory completely stripped of timber and the railways are required to bring pulp to them from other mills located far away, many even outside of our borders. In the use of paper we have been, and are still, foolishly wasteful, and yet we complain at the ever increasing costs and prices. Are not some of these increases due to persistent lack of policy and foresight? Many think so. The extended use of iron, steel, brick and cement came too late to save the wood, and brick is now so expensive as to prohibit its use for many purposes.

We never have had any nation-wide system for reforestation, although the benefits have been studied, taught and preached for years. To replace wood, it is possible that the future will cultivate quick growing trees and grind the timber into pulp, which will be pressed into various commercial shapes.

Diminishing Coal Supplies.

It is quite apparent that the nation's coal supplies should be conserved by the intelligent use of its water resources. The author made a long and exhaustive search through the best records on file, including statistics published by the U. S. Geological Survey, and the figures obtained show that the available supply in the United States is about as below:

Anthracite and Semi-Anthracite—19,000,000,000 tons.
Bituminous and Lignites—3,550,000,000,000 tons.

Trade reports show that the yearly coal production is about:

Anthracite and Semi-Anthracite—90,000,000 tons.
Bituminous and Lignites—550,000,000 tons.

At these rates, assuming that there will be no increase in production, the present available supplies would last about 200 years for the anthracites and 6,450 years for the bituminous.

Crude Oil or Petroleum.

In a similar manner records show that the amount of crude oil or petroleum in the ground in the United States is about 7,000,000,000 barrels (of 42 U. S. gallons), and that the yearly production is at the rate of about 375,700,000 barrels. According to these figures the available supply would last for only 18 years. The amount of petroleum in the ground in Mexico is unknown, but Dr. David White, chief geologist of the U. S. Geological Survey, has expressed the fear that Mexico had less oil under ground in 1919 than the United States. The yearly production from the Mexican fields is about 300,000,000 barrels, and if the available supply is taken at the same figures as for the United States, namely 7,000,000,000 barrels, that country would be exhausted in about 23 years.

There are large oil fields in Canada, but their extent is not known at this writing. As the American and Mexican wells show territory exhaustion the production from Canada should rapidly increase from the present production figure of approximately 500,000 barrels per year.

In Venezuela and adjacent countries, there is a vast resource of crude petroleum. This supply, as well as other fields yet to be discovered, will help sustain the demand for oil and increase the length of time before complete exhaustion will be reached, but they are outside of our boundaries and we will have to share their value with others.

There is a promising outlook in the oil bearing shales to be found in different parts of this country, from which fuel and possibly lubricating and other oils may be obtained. This industry has not yet been developed and it is hard to predict what the result may be.

There is danger in using the above figures through the possible and probable inaccuracy of the available supplies. This is especially true of the coal fields. There is no doubt more coal in the ground than reported, as many owners do not carry out prospecting developments beyond the limits needed properly to finance their companies. It is true, however, that the better grades of anthracite will be exhausted in much less than the 200-year limit mentioned above, and that nearly all the hard coal near the surface will be removed in the next three generations, leaving only the deeper strata for future mining operations. This also is true for the bituminous and lignite-grades, so that in a few centuries all our coal may have to be taken from depths exceeding 3,000 ft. These changes will seriously add to the cost of labor for production and raise the prices of all kinds of coal fuel.

The high cost of labor, by increasing the cost of production, is adding a burden which is seen in every walk of life. While labor should be well paid, the men have little or no financial responsibility, and each should see that every one does a "full day's work" in return for his full wage.

Value of Hydro-Electric Power Becoming More Apparent.

As time progresses the value of hydro-electric power will become more and more apparent, and, in fact, will be needed to meet the ever increasing demands for power and production.

The present need of production has brought up the question of lack of power, and in this connection we look to the water powers as a never failing source of cheap supply. In the July, 1919, issue of "Municipal and County Engineering," the author contributed an article on this subject and pointed out that great economies could be accomplished by a proper and systematic policy

for the development of our hydraulic resources. There is an erroneous impression in the public mind that any policy for water-power development would be a step to benefit private enterprise for personal gain. This is a narrow minded view and fails to grasp the broader aspect that the public is vitally interested. A policy, which will increase our national wealth and welfare, and which will be advantageous to the nation as a whole, must benefit each and every individual, either directly or indirectly.

It has been stated * that the water powers of the United States, as compared to steam powers, are:

Water powers, total potential, with storage, 200,000,000 h. p.

Water powers, not developed, without storage, 50,000,000 h. p.

Water power, developed and in use, 6,000,000 h. p.

Compared to steam power, developed, 40,000,000 h. p.

Water Storage.

Storage means the regulation of the flow of the rivers, by storing the flood waters for use in dry months, as, unfortunately, the flow is not even and continuous throughout the year. On some water sheds the variation is very wide. The primary, or all-year-round power, is limited to the minimum flow in the dry season. The full maximum flow can not be utilized, as it lasts but a short period of the year, and it does not pay to install expensive machinery to transform this flood flow into power on account of its short seasonal use.

The World's Demand for Power.

The total of the world's demand for power is extremely hard to estimate. It has been stated that the present power demand of the world is about 120,000,000 horse power† and that it is divided as follows:

For factories, electric lighting and street railways, 62½ per cent.

For railways, 20 per cent.

For shipping, 17½ per cent.

The total potential water-power of the United States exceeds this figure for the world's demand, or, in other words, the water-power of the United States could be developed to supply more than the world's demand without the use of coal, oil or fuel of any kind. In fact, the demand for power at the present time in the United States is about 46,000,000 h. p., including both steam and hydraulic installations, while there is available, but not developed, some 5[illegible],000,000 h. p., even without recourse to storage.

All Water Falls Are Not Valuable For Hydro-Electric Development.

When delivering a series of lectures at Rensselaer Polytechnic Institute in 1915, the author told the students that *all* water falls were not valuable for hydro-electric development purposes, because interest on the cost of development formed too large a proportion of the operating expenses to make some investments profitable. In brief, a development would not pay when the product of flow in cubic feet per second by the head in feet was less than 16,000. While this is not a fixed ratio, because natural advantages in some locations makes the cost of development per kilowatt, or per horse power, much less than at other places, it can be used as a close guide in forming first hand opinions. As was stated in a previous article, every project for hydraulic power development should be carefully reviewed by an engineer whose experience has made him competent to pass on the questions involved.

The following statement will serve to illustrate how the ratio just mentioned was determined:

Assuming Cost of Hydraulic Development.

Dam, head race, tail race, screens and power house, etc.	at $ 93 per kw.
Turbines, draft tubes, etc.	at 7 per kw.
Electric generating machinery and equipment	at 20 per kw.
Transmission line, transformers, etc.	at 15 per kw.
Total cost	at $135 per kw.

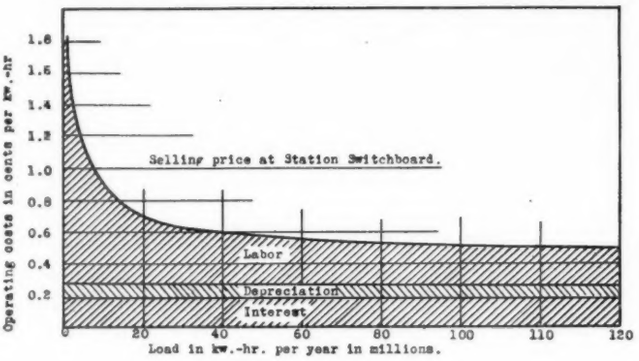


Fig. 1. Avg: cost per kw.-hr.
Note:- Cost of land is not included.

FIG. 1—CHART OF HYDRO-ELECTRIC AVERAGE OPERATING COST PER KW. HR., COST OF LAND NOT INCLUDED.

The operating costs of generating stations per kw-hour, delivered from the station switch board, on a 50 per cent. load factor basis, would be (say):

For labor, up-keep, taxes	$0.00312
For interest at 6 per cent. on $135=$8.10, which for 4,380 hours in year at 50 per cent l. f., is.	0.00185
For depreciation—	
Taken at 2 per cent. on $93=$1.86	
Taken at 5 per cent. on 27= 1.35	
Taken at 3 per cent. on 15= .45	
Total	$3.66
—which, for 4,380 hours in year at 50 per cent. l. f., is	0.00083
Total operating cost	$0.0058

The current thus generated could be sold for about $0.01 per kw-hour, as an average of primary and secondary power, at the station switch board.

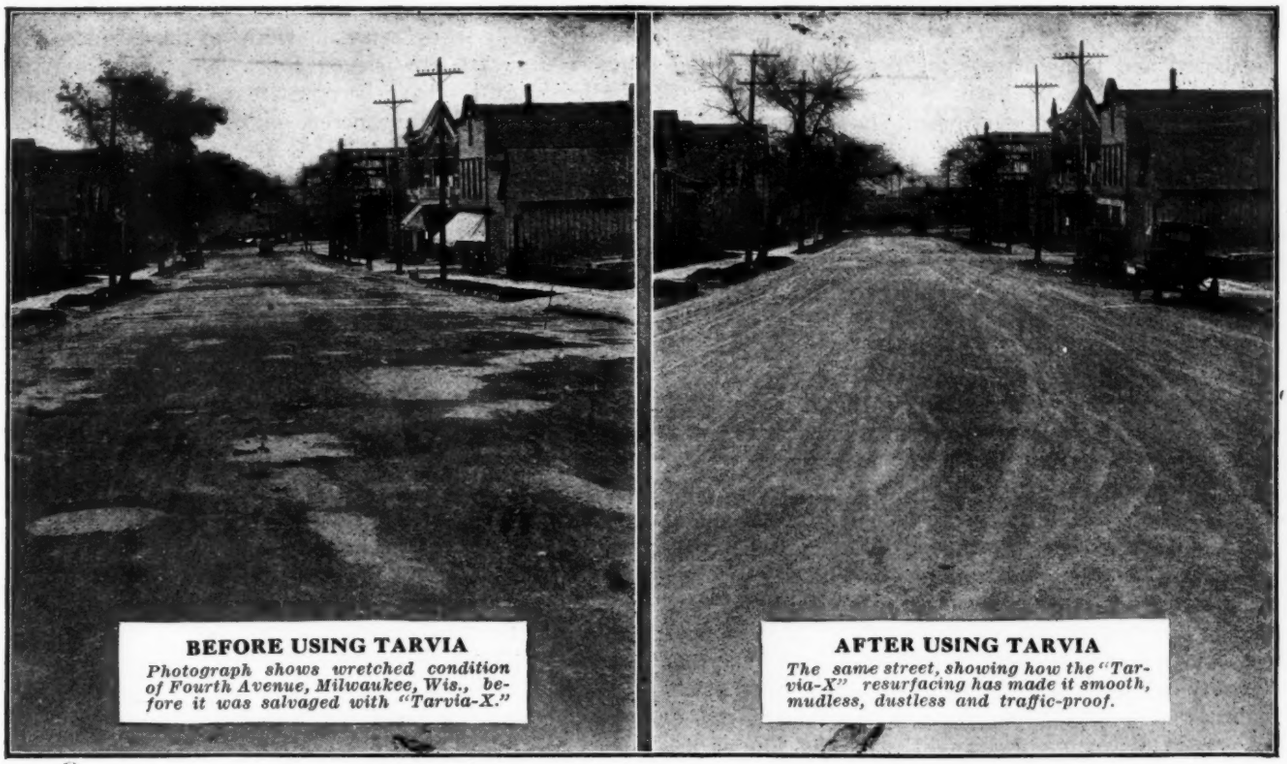
The operating costs are graphically shown in Fig. 1, and the curve rises sharply as the station load falls below 25,000,000 kw-hrs. per year. On this assumption, a development, which has a yearly load of 7,500,000 kw-hrs. or less, would not pay on an average selling price of 1 ct. per kw-hr. Such a load would require a plant having a capacity of 1,700 kw. (7,500,000 divided by 4,380).

Taking combined efficiency of turbines, generators,

(Continued on page 248)

*Power: "Its Significance and Needs." Smithsonian Institution, U. S. National Museum. Bulletin 102, Part 5.

†"Report on the Water Power Resources of India," by J. W. Meaves, M. Inst. C. E. Calcutta, 1919.



BEFORE USING TARVIA
Photograph shows wretched condition of Fourth Avenue, Milwaukee, Wis., before it was salvaged with "Tarvia-X."

AFTER USING TARVIA
The same street, showing how the "Tarvia-X" resurfacing has made it smooth, mudless, dustless and traffic-proof.

To Get Good Roads—Cheaply—Quickly—Save the Roads You Have!

MILES and miles of good gravel and macadam roads throughout the country can be restored to meet modern traffic requirements. The way to do this is to utilize the existing road as a foundation for a traffic-proof Tarvia top. And where crushed stone or slag is available, the community so favored not only can save its roads but *save* considerably *money* in the bargain.

Many progressive communities recognize this fact and are carrying out an extended *road salvage program* rather than build new roads at present exorbitant prices.

For example, the City of Milwaukee has in this way transformed 1,700,000 square yards of water-bound macadam into splendid modern streets to the complete satisfaction of both the city authorities and the traveling public.

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Tarvia Roads are durable, dustless and mudless. They are also waterproof and frost-proof and require a minimum of upkeep expense.

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Special Service Department

This company has a corps of trained engineers and chemists who have given years of study to modern road problems. The advice of these men may be had for the asking by any one interested. If you will write to the nearest office regarding road problems and conditions in your vicinity, the matter will be given prompt attention.

New York, Cincinnati, Minneapolis, Atlanta, Lebanon, Chicago, Pittsburgh, Dallas, Duluth, Youngstown, Philadelphia, Detroit, Nashville, Salt Lake City, Milwaukee, The Barrett Company, Boston, New Orleans, Syracuse, Bangor, Elizabeth, St. Louis, Birmingham, Seattle, Washington, Buffalo, Cleveland, Kansas City, Peoria, Johnstown, Baltimore

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THE BARRETT COMPANY, Limited, Montreal, Toronto, Winnipeg, Vancouver, St. John, N.B., Halifax, N.S., Sydney, N.S.

(*Continued from page 246*)

switchboard and transformers at 70 per cent., 1 kw.= 0.106 × cu. ft. sec. × head.

Therefore, a paying development should show:

0.106 × cu. ft. sec. × head, greater than 1,700

or cu. ft. sec. × head, greater than 16,000

The first cost of development of a water-power is very variable. For instance, installations of 7,500 kw. and larger, might possibly be (on a pre-war basis):

	Max.	Min.	Appr. Avg.
For hydraulic works	450	40	90
For waterwheel machinery	10	5	7
For electric machinery	150	8	20

For transmission lines—depending on length.

Plants with high heads and small flow in general cost less than those with low heads and large flows.

The operating costs of American hydro-electric stations also are valuable between wide limits, depending on location and power-factor demand. Thus, the costs for the larger stations will run from, say $11.50 to $43 per kw. per year. The selling price naturally depends on the cost. Consumers will pay for *"reliable"* power, that is power which can be relied on throughout the full year. Reliability is worth money and commands high rates. Cheap power, if unreliable, is not always economical.

As water-power is not constant, since the flow of the river is low in the dry season, only a portion can be sold as primary power, and the balance must be classed as secondary and demands a lower selling price. The loss of interest on the necessary machinery while idle is a factor which must be considered, and is a large factor on rivers where the flow has a wide range throughout the year.

Auxiliary Steam Plants.

In order to make up loss of power when water is low auxiliary steam-driven plants are kept in reserve. As coal and fuel oil are becoming scarcer and higher in cost the present tendency is to locate such steam plants at or near the mines where coal of cheap grades can be supplied. The electric generating stations, both steam and hydraulic, can be connected by a system of transmission lines running across country, and the current fed out to users as desired. It is mechanically feasible to meter the current supplied from the generating stations into the distributing system and arrange credits for each station. Such a plan would secure economies in many ways and relieve the railways from carrying coal long distances, which traffic so frequently blocks passenger and fast freight trains.

RECONSTRUCTION OF 20-YEAR-OLD ASPHALTIC PAVEMENTS IN OKLAHOMA CITY

Oklahoma City, Okla., is starting on a program of reconstruction of streets which were paved with sheet asphalt, over a concrete base, about 20 years ago.

Under the specifications for this re-construction work, the old concrete base is brought to a true contour by building up the deeper depressions with cement concrete, and the shallow depressions with close binder. A 10-ft. gutter of grout filled 3-in. vertical fibre brick set in a mortar cushion, extends from the curb on the streets which are 40 ft. or more in width, in the business sectios where cars are parked for a long period. After the brick gutters have become set a 2-in. binder course using a lean asphaltic concrete mixture is laid and rolled. On this binder course is laid 2 ins. of asphaltic concrete carrying a high percentage of fine material, especially 200 mesh, with the balance of the mineral aggregate well proportioned up to ½-in. material.

The first rolling of this wearing surface of Texaco asphalt is a cross rolling instead of longitudinal, using a 5-ton roller, which on account of brick gutters, can cover the entire asphalt surface with the large wheel of the roller. Immediately following the cross rolling a longitudinal roll is given the wearing surface, using an 8-ton tandem roller. The surface completed under this method up to date shows a minimum of waves.

Another feature which will tend to preserve a uniform surface, is the prevention of asphalt rakers from walking or standing on the hot mixture after it is handled by the shovelers and prior to rolling. This eliminates an excess of mixture in the spots which have been walked upon and receive a certain amount of compression before the roller is applied.

In this section of the country most cities demand that automobiles be parked along the curb at an angle of 45 degrees, and the gutter mentioned above should take care of this class of traffic during the summer months.

ASPHALT ROADS IN NEW JERSEY

New Jersey is known as the "Garden State of the East," and her counties are prolific in their supply of foodstuffs for the great cities in that part of the country. New York City and Philadelphia receive abundant quantities of fruits and vegetables from the fertile soil of Jersey, and an idea of the regard the metropolis holds for her supply of food coming from her neighbor state may be gained from the anxiety which exists in the city when the ferries and other means of transportation are tied up and it is impossible to get the eatables.

Burlington County, New Jersey, is one of the largest and most productive agricultural areas in the state, or in the East. Various kinds of fruits and vegetables are grown there, and consequently the means for transporting the county's foodstuffs has long been one of the chief problems of the residents. After finding that the railroads are unable to accommodate rapidly and conveniently the growing demand for its food products, the county has begun an extensive road building program.

Last season more than 10 miles of sheet asphalt were laid in Burlington County, and during the present season 20 miles of sheet asphalt will be constructed. James Logan, county engineer, is in direct charge of the work, which is being let to contractors in the usual manner.

One of the features of the work in Burlington County is the fact that the farming population is virtually unanimous in its desire for modern, high-class roads. The value and efficacy of durable highways has been proved to the farmers. A stretch of sheet asphalt extending from Mount Holly easterly towards the state capital of Trenton, is an example of these roads. This road was built in 1917 on an old macadam base, and has withstood without any maintenance all the banging, weighty traffic going to Trenton and other cities.

WATER WORKS SECTION

CENTRIFUGAL PUMPS FOR 900-FT. HEAD

By Farley Gannett and Jacob L. Crane, Jr., of Gannett, Seelye & Fleming, Inc., Consulting Engineers, Harrisburg, Pa.

The municipal water works at Shenandoah, Pa., is completing an installation of two 2-million-gallon per day centrifugal pumps, electric motor driven, to pump against a total head of 800 to 900 ft. The pumps, which are only three-stage for the head stated, together with certain details of installation, are of unusual interest. Incidentally, but by no means least important, pumping costs are to be reduced by $15,000 per year, a reduction of nearly 40 per cent.

Water Pumped Over Locust Mountain

Shenandoah is a community of about 35,000 population, situated in the heart of the famous lower anthracite coal region of Pennsylvania. The valley in which Shenandoah is located is so full of coal operations that it is impossible to secure water either from the surface or from below ground. It therefore became necessary to secure water in the adjoining valley, separated from Shenandoah by Locust Mountain about 800 ft. high. The water works plant uses the surface flow from several small mountain streams impounded in a small reservoir, and at present, the water is forced by stream pumps over Locust Mountain to the distribution reservoir and thence to the city.

Reasons for Changing from Steam to Electric Power

These steam pumps, as well as the boilers and pumping station, now 20 years old, are nearing the end of their useful life. Still more important, the advancing costs of coal, and of the two-mile haul from railroad to pumping station, and of firemen's wages, have so increased the cost of steam pumping as to cause a serious deficit in each year's water works finances. The high voltage transmission line of the Harwood Electric Company has been built since the steam pumps were installed; the electric rates, which are not expected to advance, show a large saving over steam power; the electric driven centrifugal pumps cost less than new steam pumps, require less space, are more easily and satisfactorily operated and allow the best advantage for taking power from the electric lines. It was therefore decided to put in electric-motor-driven centrifugal pumps.

Contracts and Guarantees

Contracts were drawn and bids taken on two centrifugal pumps and motors for 2 m. g. d. each against a maximum head of 900 ft. These contracts were drawn to admit bidding by almost any make of pump, but bonds and payment reservations require full performance of the terms of contract, including a required minimum efficiency overall, "wire to water." Seven bids were received and the contracts were awarded to John R. Proctor, New York for two American Well Works pumps and two 500 H. P. General Electric Company motors, at a total for all, installed, of $13,380, and a guaranteed overall efficiency of 68 per cent. Other items of the contract were: Building, about $5,000; piping, about $5.400; electrical equipment (transformers, sub-station, switchboard, instruments, etc.) $12,155.

The American Well Work pumps are three stage built for 300 ft. per stage. The shells are of cast steel, the wearing rings of bronze, shaft sleeves of bronze, shafts of forged steel and the impellers and diffusion vanes of "U. S. Government Bronze." The pumps are completed and are now being tested at the pump works. The guaranteed efficiency is noteworthy, 68 per cent. overall, "wire to water."

Protecting Old Steel Main Against Water Hammer

The discharge will be into a 12 in. steel force main 12,000 ft. long and 26 years old. The danger of blowing out this line when the pumps close down suddenly and the water slams against the check valves at the pumps, creating a water hammer which might be disastrous, in view of the length of line and high head, seemed so great that special provision was made to prevent it. The force main is divided into four sections by three check valves and just above each check valve and also at the pumps an antomatic blow-off valve is placed. This serves to divide up the length of line and also the pressure, and allows the pressure to be relieved at each of the division points. This scheme is calculated to relieve the water hammer successfully.

The installation will be completed this summer, when rigid operation tests will be made and the results, which should be interesting will be reported to the profession through Municipal and County Engineering.

WATER MAIN CLEANING IN ST. LOUIS, MO.

By Edward E. Wall, Water Commissioner, 312 City Hall, St. Louis, Mo.

The St. Louis Water Department, realizing the advantage of clean mains for clean water, has probably had more miles of water pipe cleaned than any other city. For a long time after the initial clarification of the water in 1904 local disturbances of the normal flow in the mains would stir up the deposits in low points and cause numerous complaints from consumers in the affected district because of the turbid water flowing from their faucets. To get rid of this sediment accumulated throughout the 70 years of pumping the untreated and unclarified muddy river water through the mains, a systematic and regular practice of blowing off all low points and dead ends in the distribution system was inaugurated. By this means and also through the draughts on the mains during fires,

Printed as insert to Municipal and County Engineering, Chicago, Ill., June, 1920.

and on rarer occasions of broken mains, a great deal of sediment was flushed out.

Yet there remained enough to cause serious inconvenience here and there whenever there was any considerable change in the velocity or direction of the usual current flowing through the mains.

These occurrences became less and less frequent each year, but were sufficiently annoying to give color to the suspicion that the water carrying in suspension a portion of these old deposits, was unhealthful and might possibly contain pathogenic germs.

First Mains Cleaned in 1908

In the autumn of 1908 some work at cleaning mains was done as a matter of demonstration. About 1,000 ft. of 10-in. main in Broadway and a shorter length of 6-in. pipe in the water works grounds at Bissell's Point were cleaned at a cost of $569.08. No measurements of the carrying capacities of these mains before and after cleaning were made, but the amount of incrusted and deposited material removed was found surprisingly large, and a recommendation was made that the process be continued until all the older pipe lines were cleaned.

However, nothing more was done in this direction until 1912, when about 4½ miles of 15-in. and 20-in. mains over 30 years old were cleaned at a cost of $5,517.09.

These lines were cleaned primarily to increase their capacity, so that the territory supplied through them could enjoy better pressures and a more uniform supply.

While no measurements were made of the increased capacity and no record kept of the amount of sediment and incrustation removed, yet the improvement in the service to the district supplied was very marked and encouraged the department to continue the work in 1913, when 2.62 miles of 6, 15 and 20-in. were cleaned.

Just prior to the completion of the Chain of Rocks filters the question of cleaning the mains to remove the deposits of sediment before a filtered and sterilized water was pumped into them, was again agitated, but because of the great mileage of mains which had been in service for 25 or more years, only a small fraction of which would be cleaned before the completion of the filter plant, all idea of a general clean-up was abandoned.

Plan Made in 1917 to Clean 50 Miles of Mains

On account of the great amount of construction work done from 1913 to 1917, during which time over $4,000,000 was spent in enlarging and improving the water works, the work of cleaning mains was suspended. In 1917 a comprehensive program was laid out for cleaning some 50 miles of the oldest distribution mains in the city and $50,000 was appropriated for that purpose.

This contract was completed in August, 1918. Careful observations, tests and measurements made of the incrustation removed from the mains showed the following results:

Size of main inches	Length cleaned feet	Weight of average incrustation per foot in pounds	Tons removed (dry)
6.....	58,061	0.846	24.56
8.....	15,691	1.784	14.00
10.....	1,180	2.040	1.20
12.....	115,025	3.303	189.95
15.....	7,205	3.970	14.37
20.....	70,125	6.472	226.92
Total.....	267,287 ft, or 50.6 miles		471.00

The incrustation as scraped from the inside of the pipe was found in its wet state to weigh 84.7 lbs. per cubic foot, but when dried only 68.5 lbs., losing almost 20 per cent. In cases where the main was not carrying any-

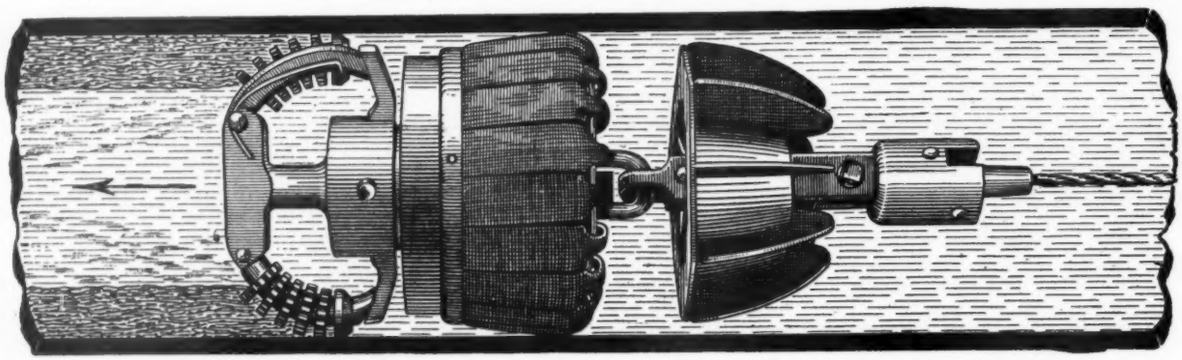


FIG. 1—VIEW OF MECHANICAL CLEANER FOR STRAIGHT WATER MAINS.

where near its full capacity heavy deposits of silt were found at the low points. This was also true of all dead ends and pipe lines where the normal currents ran with a low velocity.

Variety of Objects Removed from Mains

The variety of mobile things found in the pipe during the process of cleaning was most astonishing. A stick of timber, once 4 by 4 ins. and 6 ft. long, now with edges and ends rounded and worn away; oak wedges and hand spikes used in pipe-laying, horseshoes, paving brick abraded by traveling with the current until they resembled the granite pebbles under a glacier, broken stone, strands of rope, the remains of a workman's overalls, and even a steel drill bar 6 ft. long were among the specimens removed. With all the care usually taken in laying water pipe to see that each length is clean before putting it in the ditch, and then carefully blocking the open end at night, it is difficult to understand how some of these things could possibly have found their way into the pipe.

The presence of these moving obstructions in the pipe explains why it is often impossible to make a dry shut-off, as well as why stop-valves are found to be damaged and leaking.

Procedure in Cleaning Mains

In cleaning the smaller mains up to 10 ins. in diameter

the cleaning machine is dragged through by a cable. First a light line is carried through the pipe by a float, then the cable is attached to the line and pulled through by a windlass.

In cleaning the larger mains the machine is forced through by the water pressure behind it, the main being re-connected after the machine is inserted, and the water turned on with full pressure behind the machine. Space is allowed for a portion of the flow to pass through and around the machine so that the silt and incrustation loosened may be washed out of the way of the machine.

The Cleaning Machines

The ordinary cleaning machine consists of sections flexibly connected, each section having a number of tempered spring steel cutting and scraping blades securely fastened to a common center.

The cutting edges of these blades form a circle somewhat larger than the inside diameter of the pipe to be cleaned, so that when it is inserted in the pipe the tension on the blades is sufficient to cut and scrape away all incrustation.

A turbine type of cleaner has been designed for use in cleaning pipe where the interior deposit is very hard. This consists of a cleaning head attached to the motor of a water turbine. The cutters are pressed out against the incrustation by centrifugal action due to the rapid revolution; the stator is fitted with one of two pistons, which make a practically water-tight joint in the pipe line so that all the water flowing through the pipe must pass through and operate the turbine.

To the rear of the stator is attached a fitting which tends to prevent the rotation in the pipe of that part of the turbine which should not revolve. The entire machine is held back by a cable and specially designed windlass, as otherwise the pressure of the water would cause an uneven advance of the machine, which would jam the cleaning head into the incrustation and prevent its operation. Figs. 1 and 2 show the turbine cleaner in operation.

Rate of Progress in Cleaning

Where mains are cleaned by dragging the machine through, the length of pipe cleaned at one operation ranges from 1,000 to 2,000 ft. Where the machine is driven by water pressure as great a length of pipe as 6,400 ft. has been cleaned between openings.

The average speed of the machine when pulled by cable was 16 ft. per minute and when driven by hydraulic pressure was about 200 ft. per minute.

All service pipes connected to the main are shut off during cleaning to prevent their being filled up and clogged with silt and finely divided incrustants, yet it frequently happens that the consumer is unable to get water after the main has been cleaned until his service connection has been blown out by a plumber.

Contract Let in 1918 or Cleaning 100 Miles of Main

An appropriation of $115,000 was made in 1918 and a contract let in December of that year for cleaning about 100 miles of mains, ranging in size from 6-in. to 20-in. Up to Feb. 1, 1920, a total of 83.3 miles have been cleaned under this contract, from which an estimated quantity of 854.5 tons of incrustants have been removed.

Under the terms of the specifications the contractor guarantees that the pipe after cleaning shall have a carrying capacity equal to 95 per cent. of new pipe. Random tests made before and after cleaning show that with two exceptions in all cases where the machine was driven through the main by water pressure the capacity of the cleaned pipe was equal to or greater than that guaranteed. In the one case noted the pipe was re-cleaned, after which the test showed the required capacity.

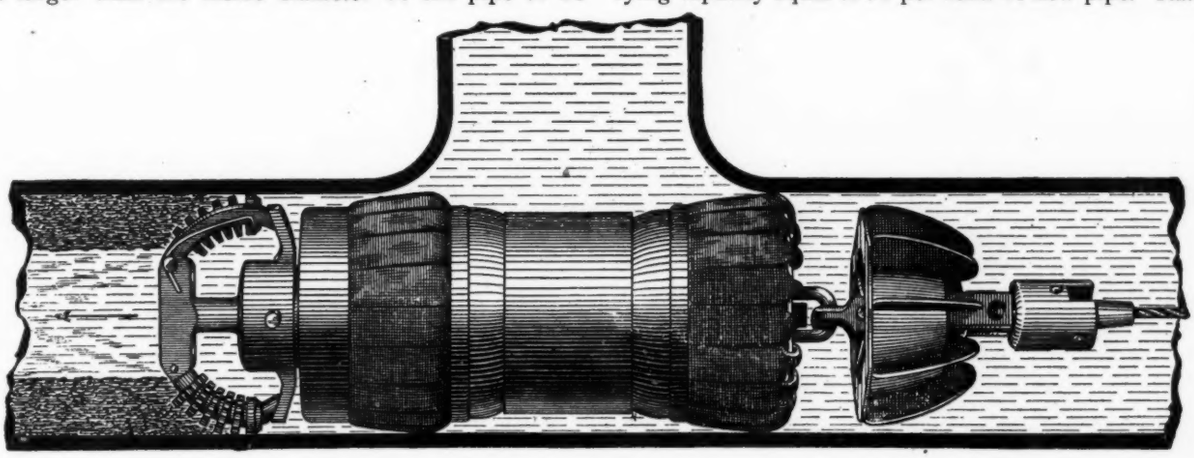


FIG. 2—VIEW OF MECHANICAL CLEANER FOR BRANCHED WATER MAINS.

In testing some 6-in. lines immediately after cleaning they were found to have the capacity specified in the contract, viz., 95 per cent. of that of new pipe. For example a 6-in. main on Pine street beore cleaning showed that its capacity was only 33 per cent. of new pipe, while after cleaning its capacity was 96 per cent.

Degree of Permanency of Results

However, several other lines where the efficiency of the cleaning was just as marked have deteriorated very rapidly to about 65 per cent. of new pipe, which value they seem to hold.

In this connection examinations of sections of 6-in. pipe after cleaning show the coating abraded and rust streaks in the process of forming. This neutralizes to some extent the good accomplished by cleaning.

Tests made on 6-in. pipe from 3 to 11 months after cleaning show a falling off in carrying capacity which can only be attributed to the rapid accumulation of rust about these abrasions. Apparently it is going to require a rather close adaptation of the strength of the spring steel scrapers to the quantity and hardness of the in-

crustant in order to have a machine which will insure a thorough cleaning and yet not injure the interior coating of the pipe.

It is intended this year to clean at least one pump main, probably the one leading from the Bissell's Point pumping station direct to Compton Hill reservoir, a distance of 4.36 miles, two-thirds of which is 36-in. in diameter, the rest being 30 ins. This pipe was laid in 1868-70 and was the first pump main connecting the new pumping station with the new reservoir.

Should tests after cleaning show a decrease in friction loss sufficiently large to justify the expense, about 7 miles more of the 30 and 36-in. pump mains will be cleaned.

Conclusion

When it is considered that the tests show an increase in carrying capacity ranging from 85 to 92 per cent. after cleaning, there can be no doubt that water main cleaning should be seriously considered by all cities whose mains have been in service 20 or more years. Wherever there occurs an inadequate supply or decreased pressures in districts where the mains were laid years ago it is certain that cleaning will afford relief. There have been several instances in St. Louis where the service has been so materially improved after the main has been cleaned that plans for replacing the existing line with new and larger pipe have been dropped.

The best evidence of the beneficial effects of water main cleaning in St. Louis lies in the fact that this work is being continued from year to year.

AMOUNT OF LEAKAGE IN SMALL WATER WORKS SYSTEMS

By Lawrence W. Cox, Consulting Civil Engineer, 1102 York St., Des Moines, Ia.

In Iowa, as well as in many other states, a large portion of the small cities and towns find it practically out of the question to secure adequate water supplies. In addition to inadequacy of supply, a great number of these municipalities secure such water as they do have, from considerable depths, a head of 200 ft. to 400 ft. below ground level being quite common. The capacity of these wells is often as low as 15 G.P.M. Water in such small quantities and pumped from such depths is expensive at best, due not only to the power consumed but also to the relatively high first cost, interest, depreciation and maintenance costs of the well and pumping equipment. For these reasons it is imperative that leakage in the mains be reduced to the lowest practical limits.

Leakage From New Mains

Among the laymen and even some practical water works construction men there seems to be the opinion that water mains when first constructed, can be absolutely water-tight. It is not uncommon to hear a water works superintendent say that a certain system of new mains has no leaks. Upon questioning it is usually found that the statement is based on the fact that after backfilling the pipe and turning on the water, no leaks forced water to the suface. Several tests under such circumstances have shown actual leakage amounting to 1,000 or more gals. per mile of pipe per 24 hours. No leakage is an ideal condition that is seldom if ever met with in actual practice. The writer has tested but one such main. It was scarcely a half mile long and was constructed under his supervision under almost ideal conditions. Nevertheless there is a limit to the necessary amount of leakage in new systems, where care is used in the construction work.

The water mains in town of 1,000 population and less usually consist of a small amount of 8-in. cast iron pipe, some 6-in. cast iron pipe and considerable 4-in. cast iron pipe, all made up with lead joints. Sometimes a small amount of 1½-in. and 2-in. galvanized iron screw joint pipe is also used. The writer has made numerous tests of these lines but finds no good reason for believing that one of these sizes of pipe gives on an average a greater rate of leakage than another. Therefore in his specifications he makes no distinction as to the allowable rate of leakage in the various sizes of pipe.

Results of Leakage Tests

Below are a few results of definite leakage tests. These tests were, with but one exception, made before services were connected up, and in this one case services were all shut off at the curb line. The rates of leakage are in terms of gals. per 24 hours per mile of pipe. The pressure given in each case is the approximate average pressure for the entire system, in pounds per sq. in. In each case the trenches had been backfilled from one week to several weeks or months.

The test data follow:

Locality	Pressure and other conditions	Leakage per 24 hours per mile of pipe
Clara City, Minn.—		
	Pressure 50 lbs., by elevated tank test...	660 gals.
	Pressure 115 lbs., by hand pump test....	750 gals.
	After repairing one leak, pressure 115 lbs. by hand pump test.....	330 gals.
Underwood, Ia.—		
	Pressure 45 lbs., elevated tank test.....	300 gals.
George, Ia.—		
	Pressure 45 lbs., elevated tank test.....	2,500 gals.
	This rate was reduced to..... (This line was reported to have had an open trench test made, when laid, showing all pipe absolutely tight before backfilling.)	750 gals.
Pine Bluffs, Wyo.—		
	Pressure 80 lbs., stand pipe test.....	900 gals.
Donnellson, Ia.—		
	Pressure 45 lbs., elevated tank test.....	410 gals.
Lehigh, Ia.		
	Pressure 100 lbs., elevated tank test.....	445 gals.
	When extreme care was not used in closing the gate valves at the pump the leakage amounted to approximately...	1,000 gals.
Wanda, Minn.—		
	Pressure 45 lbs., elevated tank test, no measurable leakage	000 gals.
Colo, Ia.—		
	Pressure 45 lbs., elevated tank test,.....	294 gals.
	Previous to the repair of one or two leaks the rate had been.....	460 gals.

Jewell, Ia.—

Pressure 60 lbs., hand pump test, first line of mains ..... 340 gals.
Second line of mains..... 450 gals.

Numerous other tests have been made giving similar results. Part of the above work was constructed without definite leakage limit clauses in the contracts and in some cases the contractor was also engineer on the work. Taking all conditions and data into consideration, it appears that under normal conditions a maximum rate of leakage (average for an entire system) of not over 400 gals. per mile of pipe per 24 hrs. could be secured.

It is the writer's opinion that no water mains should be constructed without definite leakage limits the specifications and without definite leakage tests upon completion of the work. Large leaks even where the water is plentiful and cheap are certainly undesirable and under many conditions may not make themselves apparent at the surface of the ground. Where there is a scarcity of water it is almost imperative to avoid large leakage.

Individual Leaks Usually Small

Leakage in the amounts tabulated above seldom occur as but one or two large leaks, but usually represent numerous small seeps, some through the pipe joints, occasionally some through the valve stems, occasionally some through small defects in the pipe and some through the valves of the fire hydrants. Such leaks at the joints are too small and inaccessible to be detected by the ordinary instruments and where they do not show at the surface of the ground, if they are to be located at all it will ordinarily be necessary to go over the line systematically and dig down to the joints. Where gate valves have been placed at frequent intervals, the section of pipe wherein the greatest loss of water occurs can be easily determined by leakage or shrinkage tests. Very sensitive tests can be made by hand test pumps or with elevated tanks or stand-pipes.

Penalty and Bonus Clause in Contract

Where leakage does not exceed 650 gals. per mile of pipe per 24 hrs. it seldom softens the ground at the surface or otherwise gives surface indications. However, should it occur that this amount of leakage is principally in one or two places it may show at the surface in dense soils, such as clay. Such leaks will usually give indications at the surface of the ground within one or two weeks and some times within a few hours. Where the water supply is ample and the leaks do not show at the surface of the ground, the writer does not consider a loss of 650 gals. per mile per 24 hrs. as serious, but where the water supply is meager, say 15 to 50 G. P. M., the writer has often included in the specifications a light damage clause for leakage in excess of 425 gals. per mile of pipe per 24 hrs. and a corresponding bonus clause for leakages amounting to less than 425 gals.

THE USE OF CENTRIFUGAL PUMPS IN MUNICIPAL WATER PLANTS

By Russell A. Murdoch, C. E. Consulting Engineer, 706 Free Press Building, Detroit, Mich.

This article should be chiefly useful to those engineers who are called upon, from time to time, to choose the type of pump to be used where several types seem possible.

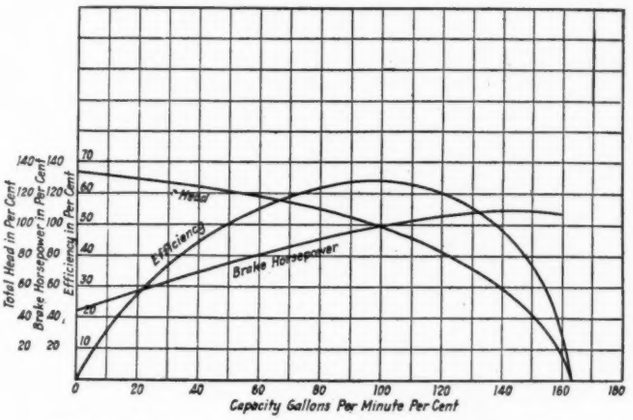
In dealing with this subject it will be necessary to touch slightly upon the power pump in general.

Power pumps are classed generally as follows:

(a) Reciprocating pumps; (b) rotary pumps; (c) centrifugal pumps.

A reciprocating pump is, as the name implies, one in which the water is displaced by reciprocating pistons or plungers. This necessitates the transformation of a rotary to a reciprocating motion, since the motion of power delivery of practically all prime movers is rotary.

A rotary pump is one which works by displacement produced by the rotation of two intermeshing cams, which, in the smaller sizes usually take the form of gears.



TYPICAL CHARACTERISTIC CURVES OF A CENTRIFUGAL PUMP, CONSTANT SPEED.

We may define a centrifugal pump as one in which the water is delivered due to the action of a rotary part (the impeller), causing the water to rotate in the casing and, by centrifugal force, due to its rotating motion, to be thrown outward to the spaces provided in the casing, whence it is delivered through the proper passages to the discharge.

Types of Centrifugal Pumps.

Briefly, we may outline the various types of centrifugal pump as follows: "Turbine." "Volute."

(1) Single suction.

(A) Open impeller. (a) Single stage, horizontal or vertical.

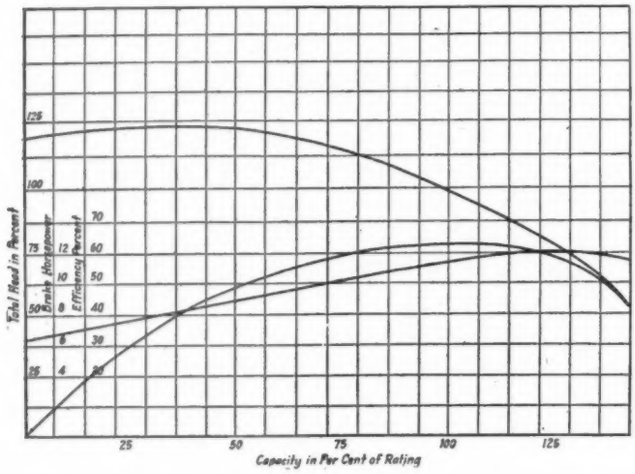
(B) Enclosed impeller. (a) Single stage, horizontal or vertical; (b) multi-stage, horizontal or vertical.

(2) Double suction. (A) Single stage. (B) Multi-stage.

The centrifugal pump is very well suited to certain classes of service. Designs have, within recent years, been worked out that would have been considered as utterly impossible 12 or 15 years ago.

Where, a few years ago, this type of pump was regarded as a rather interesting, but impractical scientific toy, good only for large volumes against low heads, and it was even stated by good engineers that its efficiency could never be over 25 to 30 per cent., public opinion has now rushed to the other extreme and many engineers and technical men (not to speak of laymen) demand a centrifugal pump for every installation, regardless of its suitability for the conditions of operation.

It is hardly necessary to say that such people have not the slightest conception of the theory and design of centrifugal pumps, and it is to be regretted that they are in such a large majority, as such a course of action is very likely to bring into disfavor one of the most useful types of pumping machinery we have.



TYPICAL CHARACTERISTIC CURVES OF A CENTRIFUGAL PUMP OPERATING AGAINST A MEDIUM HEAD, CONSTANT SPEED. RATED CAPACITY 700 G. P. M.

It is also to be regretted that there is probably more misunderstanding regarding the centrifugal pump today than there is in connection with any other piece of apparatus which is in equally common use.

Advantages and Disadvantages of Centrifugal Pumps.

Within its limits the centrifugal pump is extremely useful and has many advantages over any other type of pump. If its limitations are to be exceeded, however, it is far better not to use it at all, as nearly every advantage will be foregone and it is likely to prove a detriment to the installation.

Its principal advantages are:

1. Simplicity.
2. Compactness.
3. Low first cost.
4. Lack of reciprocating parts.
5. Good efficiency.

Its principal disadvantages are:

1. Lack of suction.
2. Sensitiveness to changes in speed and head.
3. General lack of knowledge of its characteristics among both consulting and operating engineers.

It is not fair to charge up against the apparatus the misrepresentation on the part of careless or unscrupulous manufacturers or salesmen, which are the cause of considerable dissatisfaction on the part of the purchaser, when the installation is finally completed, due to the incompatibility between the pump characteristics and the operating conditions.

The Action of Centrifugals.

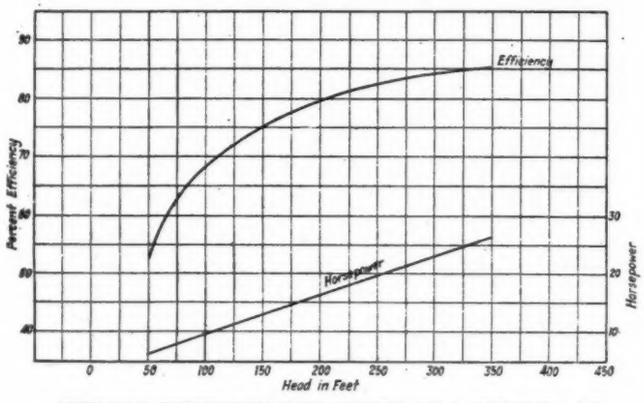
While it is not the intent of this article to go into the details of pump design, nevertheless it is not out of place to say a few words regarding the action of centrifugals, as they are becoming a more and more important feature of water works engineering as time goes on.

Since a centrifugal has no suction, if it is desired to actuate it automatically, it is evident that it must be installed with "flooded suction"— i. e., so that the water flows through the suction piping to the pump.

Foot valves and primers are sometimes used, but they are not entirely satisfactory, as they are too susceptible to leakage.

It is preferable to keep the suction lift of all pumps as low as possible, on centrifugals especially so. In the case of a plunger or reciprocating pump, high suction lifts may be compensated for in a measure by selecting a large-sized pump and running it at low speed, thus allowing the cylinders to fill more easily than would be the case if a smaller pump were run at a higher speed. With a centrifugal pump, however, this can not be done, as the speed (with a given number of stages) has to be suited to the discharge pressure required.

Neither is it economical to use a large diameter of impeller at a slower speed, as the impeller is, from elementary considerations, a water brake, and, since the brake action varies as the fifth power of the diameter of the impeller, it is evident that doubling the diameter increases the brake action 32 times, due to this increase. The brake action depends, of course, on the friction between the impeller and the surrounding water, and also upon the adhesion of the water to the impeller (which may be considered, naturally, in connection with the friction). Since the friction between two moving bodies in contact is a function of their relative velocity, it follows that the brake action is a function of the velocity of the impeller—i. e., its speed. But since the linear velocity of any point on the impeller depends upon the semi-diameter (radius) it follows that the brake action must



TYPICAL PERFORMANCE CURVE OF A SINGLE ACTING TRIPLEX PUMP, SIZE 7x10 INS. CAPACITY 250 U. S. G. P. M. CURVES BASED ON CONSTANT DELIVERY-VARIABLE HEAD.

be some function of the diameter. As a matter of fact the brake action of the impeller varies only as the square of the speed. Inasmuch as the brake action of the impeller is one of the internal losses of a pump, it is very evident that a small diameter and high speed impeller will be much more efficient than a large diameter impeller running at a slower speed, both delivering against the same pressure.

This explains why some manufacturers will bid upon a pump of more stages than others. They save the brake energy by using smaller impellers, the speed being also kept down by using more stages, and, consequently, obtaining less pressure per stage.

This fact explains why the efficiency of a centrifugal (or turbine pump) is not dependent entirely upon workmanship or design, as, by using a larger number of smaller impellers, the saving made by reducing brake losses may offset careless or improper design. Such a piece of apparatus may, of course, be cheaper, but it embodies more wearing parts and, while the material may be of the best, and the commercial efficiency high, nevertheless it would be a compromise to obtain the desired result.

Briefly, the pump which will do a certain work with the fewest number of stages with equal or less horsepower than another is of better design—i. e., its design comes closer to fulfilling the requirements. It is important to remember that this brake energy is not indicated in any way by the so-called "characteristic curves" of a centrifugal.

Formula.

The following facts may be briefly stated:

For a given impeller, (1) the capacity varies directly as the speed, (2) the pressure ($\frac{mv^2}{r}$) varies directly as the square of the speed, (3) the horse power

$$= \frac{\frac{\text{(foot pounds per min.)}}{33000}}{\frac{\text{gallons per min.} \times 8\,1/3 \times \text{head in pounds} \times 2.3}{33000}}$$

$$= \frac{K_1 \times \text{capacity} \times \text{head in pounds} \times K_2}{K_3}$$

$$= \frac{K \times K_1 \times K_2}{K_3} \times s \times s^2 = K_4 \times s^3$$

varies as the cube of the speed.

In the above

$K_1 = 8\,1/3$ is the factor for converting gallons into pounds (weight)

$K_2 = 2.3$ is the factor for converting pounds into feet (pressure)

K_3 is the number of foot pounds in a horsepower (33000) per minute.

K_4 represents $\frac{K.K_1.K_2}{K_3}$

Where K is the combined proportionality factor between the speed and the capacity and pressure.

These are the same formulae as are used for steel plate fan computations.

Hence, by doubling the speed of a certain impeller it will deliver twice the capacity against four times the pressure, but it will take eight times the pressure to do it.

Since the maximum pressure developed by a centrifugal pump is independent of anything but the speed of the impeller, it follows:

(1) That it may be used to advantage to discharge into a closed system without fear of excessive pressure developing.

(2) The discharge valve may be shut off without harming the pump, (provided it is done so as to avoid water hammer.)

(3) When the discharge valve is closed, since the pump is delivering no water, theoretically the horse power equals zero, because, in the above formula, capacity equals zero; hence, the numerator of the fraction being zero, its value is zero. Practically, however, we have the brake action of the impeller and also the friction of the bearings, etc. This explains why the horse power curve does not start from zero at zero capacity.

In the above items are covered the principal inherent differences in action between a centrifugal and a positive displacement pump.

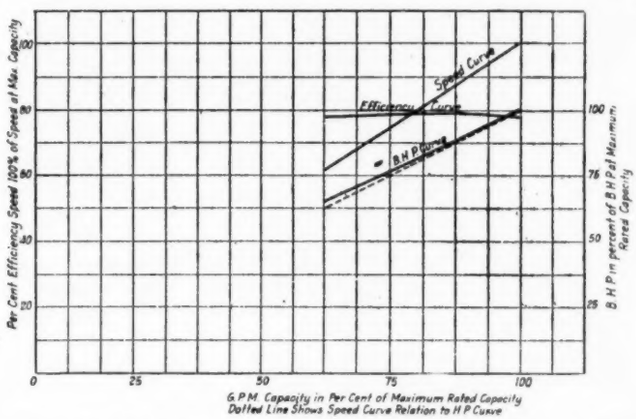
In the latter, any pressure (up to the safe working limit of the pump) may be pumped against at any desired speed, (and consequent capacity) provided the required horse power is available and provided the speed exceeds the R. P. M. slip. The centrifugal, on the other hand, is extremely sensitive to variations in:

(1) Speed.

(2) External resistance, i. e., variations in the discharge pressure or "counter pressure," because—

(1) Any variation in speed changes the delivery (capacity) accordingly and *also the pressure against which the pump will operate.*

(2) Since, at a given speed, the maximum pressure is fixed, it is evident that, if the external resistance be increased beyond a certain point, the pump will no longer deliver water, but will simply churn the water in the casing. In fact, such a condition may be demonstrated by gradually closing off a valve in the discharge line. The discharge will gradually decrease as the resistance increases, until, at the point where the counter pressure equals the pressure developed, no water will be discharged.


Per Cent Efficiency Speed 100% of Speed at Max. Capacity
Speed Curve
Efficiency Curve
B.H.P. Curve
B.H.P. in percent of B.H.P at Maximum Rated Capacity
0
25
50
75
100
G.P.M. Capacity in Per Cent of Maximum Rated Capacity
Dotted Line Shows Speed Curve Relation to H.P. Curve

TYPICAL CURVES SHOWING OPERATION OF TRIPLEX PUMP AGAINST CONSTANT HEAD.

Note—Data taken from Manufacturer's Bulletins. Type of Pump not Selected to Show Highest Possible Efficiency but rather with view of Obtaining a Typical set of Curves. The Efficiency of a Triplex Pump often runs between 80% and 85% Maximum.

Conversely, it is apparent that, if we have a pump delivering a certain capacity against a certain discharge head, and this head is *decreased* the delivery will be *increased.* As a matter of fact the increase will be rapid, more rapid than the reduction of head to which it corresponds.

Referring to the general formula,

(*Continued on page 258*)

lished reputation for ...ch service admi...
one argue against facts like these.

250 Years of Service at Versailles, France
210 Years of Service at Weilburg
165 Years of Service at Claremont, Ferrand
120 Years of Service at Glasgow and London
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IF there is any uncertainty in your mind as to the wisest choice of pipe for underground work, reflect on these words of a well-known authority—

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Pipe costs money—you know that, and also pipe which fails to render satisfactory service costs you more money—then it is but wisdom to invest in the pipe which for Centuries of Service have but proved its ability to render long faithful service, thanks to its being endowed by Nature herself with the preservative needed to Cure the Curse of Corrosion.

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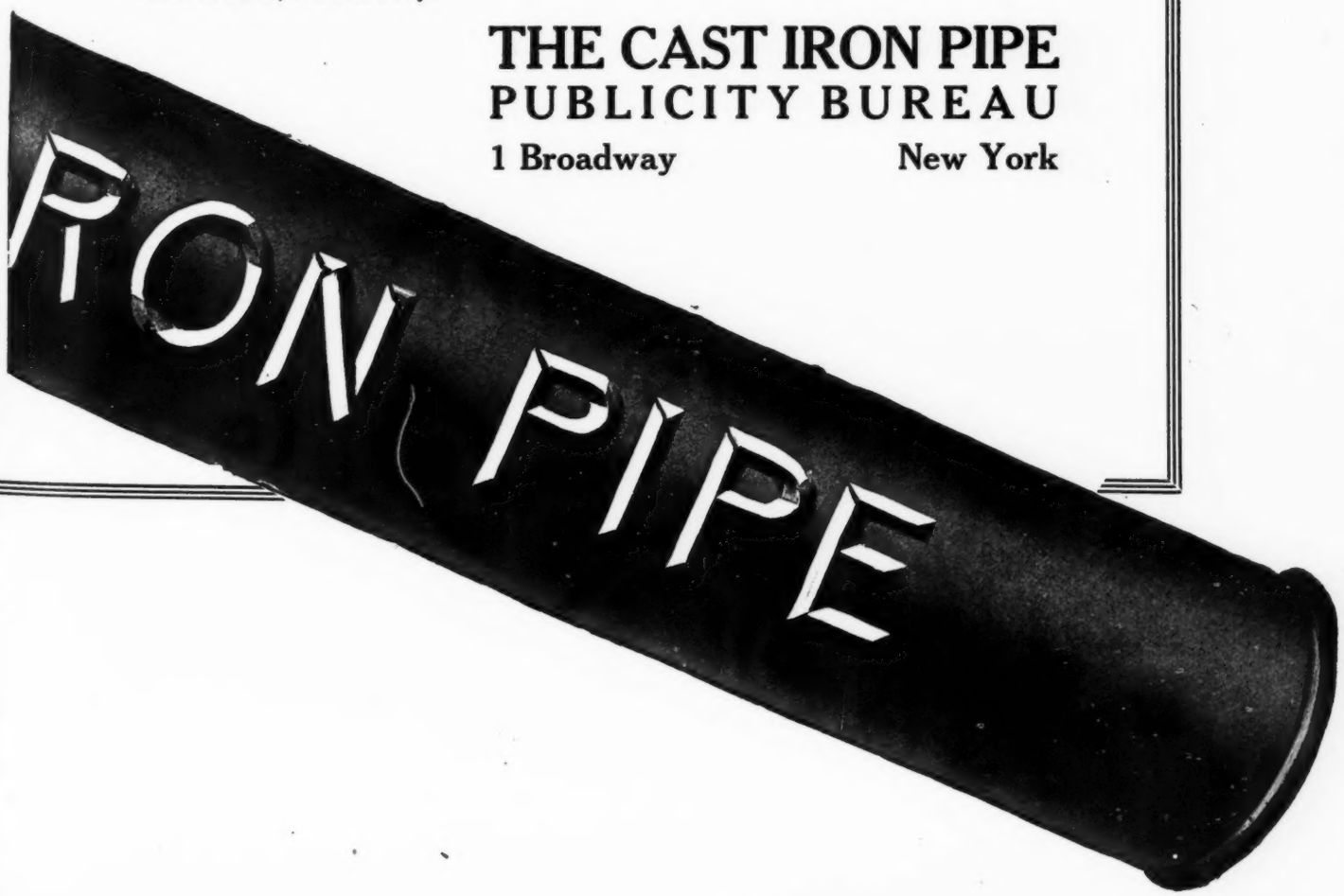


(Continued from page 255)

$$\text{H. P.} = \frac{8\,1/3 \text{ G.P. M.} \times 2.3 \times \text{pressure in pounds}}{33000}$$

if the G. P. M. increases more rapidly than the pressure decreases, it is evident that the horsepower will be decreased.

This brings us to the most important development in the design of the centrifugal pump—i. e. the "non-overload" impeller.

By this term we signify an impeller of such form that, if the pump be designed to deliver a certain capacity against a certain head, and the head should, by accident or design, be reduced even to free discharge at the pump, the increase of capacity (the speed being constant) will be so regulated (automatically, by the design) that the load on the prime mover will not be increased beyond a certain point (usually about 10 per cent. increase) and may, beyond a certain point, actually be decreased. In other words the maximum horse power curve should be convex upwards, with a well defined maximum (see characteristic curves herewith). This feature is embodied, today, in the designs of nearly all manufacturers.

Relation Between Power and Speed.

There is a definite relation between the power and speed in connection with a centrifugal pump. The power required drops off more rapidly than the corresponding speed; hence, less power is required to drive the pump at slower speed, and, consequently, less current passes through the rheostat—e. g. since the horse power varies as the cube of the speed, at half the speed, one-eighth normal horse-power would be required. Further, neglecting the lowering in virtual resistance of the armature, due to slower speed, one-eighth the normal E. M. F. would be required at the terminals (actually, it would be less than one-eighth). This would mean seven-eighths of the E. M. F. would be applied to the resistance (rheostat), but, since, in a series circuit, the current is the same in all parts, one-eighth the normal current passes through it.

The loss in resistance is—$W = I^2R$

Where W equals watts power lost, I equals current in rheostat, R equals resistance of rheostat.

Hence, only one sixty-fourth of the loss takes place that would take place if the whole current were passed through the rheostat and armature.

Now, since the applied E. M. F. is the same (across motor and rheostat combined) always (neglecting variable voltage due to "regulation"), there is a greater loss when the full current (eight times as much) passes through the armature, whose resistance is only one-eighth of the combined resistance, for, the I^2R formula being true,

I^2 becomes 1 instead of 64 and

R is one-eighth;

hence, the I^2R loss may *roughly* be compared as being as one times one-eighth, as opposed to one sixty-fourth times one, or as one-eighth to one sixty-fourth—i. e. eight times as much.

The above is only very rough and neglects electrical losses, etc. in the motor; it also assumes that the current in the field of the motor remains constant while that of the armature changes. This is not true, as the shunt field and the armature are in parallel across the line. It will serve, however, to show that armature control of centrifugal pumps is far from being as wasteful as might be expected.

Attention may be called to the fact that some manufacturers rate their centrifugal pumps as requiring so much horse-power per 10 ft. of head. This is not correct.

In the first place the friction horse-power must be considered. In the second place the brake horse-power curve is not a straight line, but a curve. The horse-power per 10 ft. of head must, therefore, be only an approximate figure. The curves show typical forms and it will be evident from them wherein the error lies.

Automatic Control.

A few words must be said in connection with automatic control.

The pressure regulator should be used where the area of the water storage is small and the pipe is high making a large variation in the pressure, or, when a float switch would be likely to get out of working order by freezing or some other cause.

The float switch is very good where the area of the storage reservoir is very large and the change of pressure very small.

From the foregoing considerations and from the shape of the characteristic curves it is very evident that it is quite necessary to know as nearly as possible the exact condition under which a centrifugal pump is to operate in order to be able to select the proper pump for the service. This is to be borne in mind when dealing with the manufacturer of such apparatus as a conscientious and reputable manufacturer will hesitate to bind himself to assume any responsibility for the operation of a centrifugal pump unless he knows exactly the nature of the service for which it is intended.

If this detailed information is not forthcoming, he will make certain assumptions upon which to base his guaranties and recommendations. If the assumptions do not happen to be correct, confusion will inevitably result —either in connection with the tabulation of the bids, or else, when it comes to the final test of the apparatus for acceptance.

In either case it will be plain to all concerned that the responsibility rests with the engineer for his failure to supply the manufacturer with proper data.

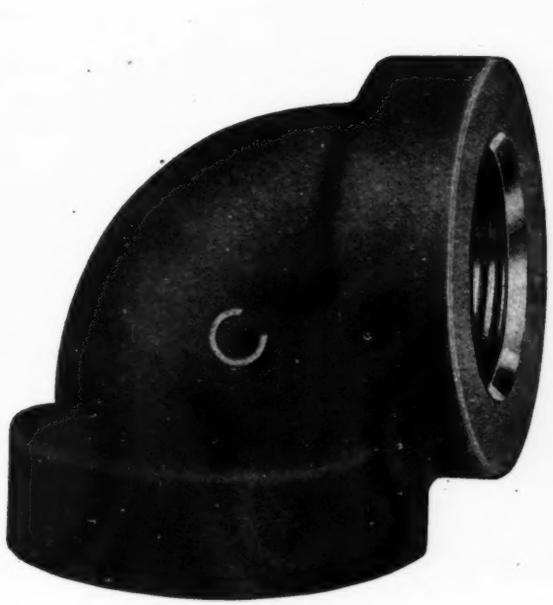
HOW TO AVOID BOILER SCALE

To avoid boiler scale, rather than remedy its evils, was long a problem with water rectification engineers. It is no secret that removal of the incrustation which hard water leaves on boilers and pipes has cost industry literally millions of dollars.

A few years ago experiments were began with a zeolite found in the Black Hills country of South Dakota. By the proper processing of this mineral, which has the property of exchanging sodium for the lime and magnesia salts present in water, it was learned that disintegration could be overcome and the life of the zeolite prolonged practically indefinitely.

(Continued on page 260)

A fitting that is stronger than the pipe



Elbow
3000 pounds pressure

Elbow
6000 pounds pressure

CRANE

FORGED STEEL

Screwed Elbows and Tees

These fittings are forged solid and then drilled and tapped for the required pipe size. Straight and reducing sizes can be furnished. Where a higher safety factor is desired we can furnish fittings made from larger blanks than regularly.

Recommendations:

For superheated steam;
Sizes ½-to 2½-inch—any existing pressure and temperature.

For extreme high pressure air lines;
Sizes ½- to 2½-inch—any existing pressure.

For ammonia and carbon dioxide lines;
Sizes ½- to 2½-inch—any existing pressure.

For Hydrostatic pressures;
Sizes ½- to 2½-inch—3,000 pounds pressure.
Sizes ⅜- to 2 -inch—6,000 pounds pressure.

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24-inch line looking south from Dam, through Medicine Canyon.

30,000 Feet of 24-inch

"U. S." Bell and Spigot pipe laid through the roughest kind of country; hugh boulders, dips from 12 to 20 feet, and ALL WITHOUT A SPECIAL CASTING OF ANY KIND. The line has given excellent service, testifying the economy and advantage of the Bell and Spigot joint.

Cast Iron Pipe holds many service records in this country—112 years in Baltimore, 100 years in Philadelphia, 80 years in New York, etc.

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San Francisco—Monadnock Building.
Buffalo—957 E. Ferry St.
Minneapolis—Plymouth Building.

(*Continued from page* 258)

That discovery meant that this zeolite, nature's own water softening mineral, could be turned to commercial use. There remained only the need of a suitable mechanical apparatus or system.

In steam power plants, central heating plants, institutions and similar industries the country over, this mineral is today removing from the feed water the properties which cause scale.

It has enabled these industries to prevent the enormous waste of fuel which scale causes, to save the time and labor ordinarily required in drawing fires and cleaning out the troublesome incrustations and to avoid the rapid depreciation of equipment which comes as a result of boiler scale.

The system, which is known as the Refinite Water Softener, consists of a container in which is a bed of the Refinite mineral or processed natural zeolite, and the necessary inlet and outlet valves. It connects to the line supplying water for the boilers.

Feed water enters the container at the top and passes through a bed of Refinite to an outlet. The simple natural exchange action takes place at this time. The water is rendered absolutely soft. There is nothing in it when it reaches the boilers that can cause scale.

Each system is built to soften or remove the scale-forming properties from a given number of gallons of water of a specified hardness in ten hours. Ordinarily at the end of that period the mineral is so saturated with lime and magnesia salts that it must be recharged. This is done by simply allowing a solution of sodium chloride (common salt water) to stand in the container over night. The following morning this is flushed out and the mineral is again ready for a day's run.

These systems are used extensively as well in textile mills, where water of no hardness is so essential; in machine shops, etc., and in homes. They require no expert supervision and their operation is entirely automatic.

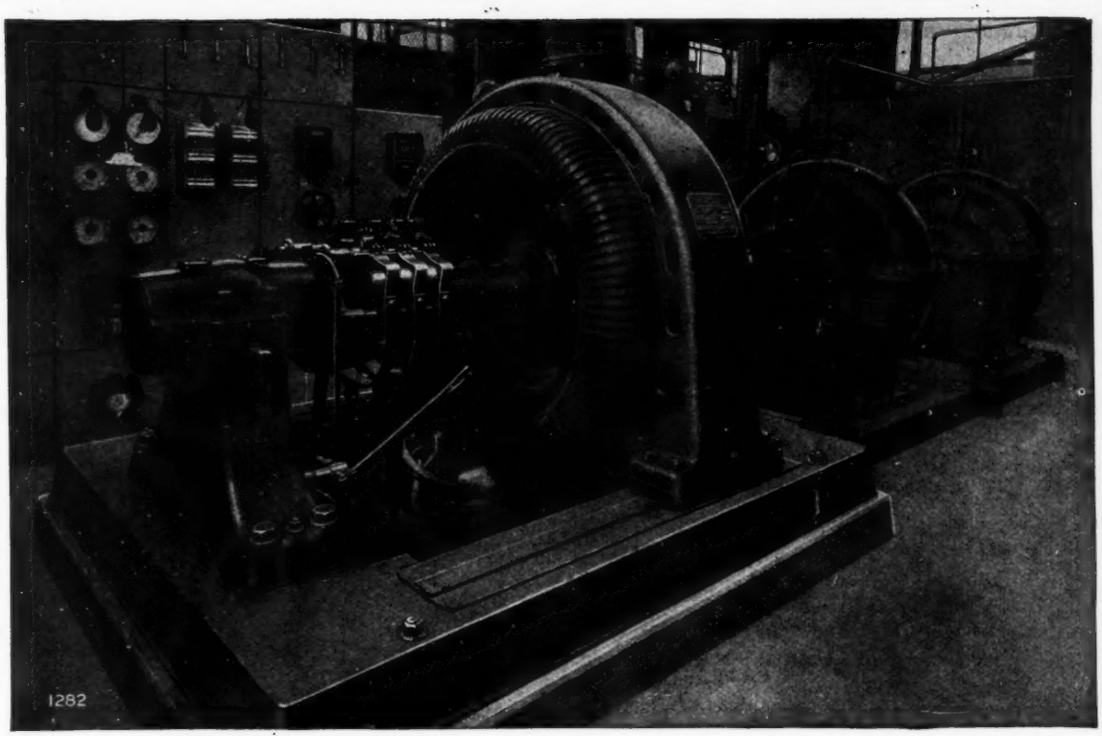
EXPERIENCES IN AN ARTESIAN WELL CONTRACT

By Jerry Donohue, Consulting Engineer, Sheboygan, Wis.

The writer has during the past ten years had considerable experience in making plans and specifications for water works installations in Wisconsin cities and villages where the population of the community was under 5,000. The cost of these systems ranged from $20,000 to $75,000. Under present conditions, however, many cities have been forced to abandon their water works plans because of the prevailing high prices of materials. This has created many new problems which engineers have had to meet by either decreasing the size of both distributing mains and storage tanks, or by eliminating other important parts of the system which towns will ultimately need. The one feature, however, which the writer feels should be carried out in spite of the prevailing high prices, is the drilling of wells, which are usually the source of water supply for cities of this class. How cities contemplating the construction of a water supply system

(*Continued on page* 262)

DE LAVAL



Two De Laval 24-inch pumps driven by three-phase induction motor. 30,000,000 gals. per day against 250 ft. head.

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THE two De Laval Centrifugal Pumps shown above deliver 30,000,000 gallons per day against 250 ft. head. At this rating, using power at two cents per kilowatt hour, 1% in efficiency amounts to over $2,000 per year.

As a matter of fact, the efficiency of these pumps is 82.5%, that is 5 to 6% above the best previous record. Full particulars will be supplied upon request.

The efficiency and capacity of De Laval Pumps is guaranteed, and a comprehensive test is made before the pump leaves the shop. This policy of testing, with the use of high grade materials, skilled workmanship and first-class shop facilities, has lead to a continuous improvement in pump efficiencies and to the maintenance of a high average.

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Ask for Special Publication B-92

DE LAVAL STEAM TURBINE CO.
TRENTON, NEW JERSEY

(*Continued from page 260*)

can start their program of construction under present conditions, is the problem before us at this time.

The necessity of getting the well drilled in advance of the construction of the remaining part of the system is best exemplified by reciting the history of a case that a small city experienced where the drilling of the well might have delayed the supply of water to the town, had not the community had the foresight to see the necessity of entering upon the part of the program well in advance of the general contract.

Well at Chilton, Wis.

The City of Chilton, Wisconsin, a city of approximately 2,000 people, located about 30 miles South of Green Bay on the Chicago, Milwaukee and St. Paul Railroad, discussed the need of water works for ten years before the community at large finally demanded that the city take some action. The City Council, therefore, in October, 1916, adopted plans and specifications covering the construction of a complete water works system, including the drilling of an artesian well; the installation of the distributing system, which also included two river crossings; the erection of an elevated steel tank of 80,000 gal. capacity; and the construction of a small pumping station to house the pumping equipment necessary to put the water from the artesian well into the elevated steel tank.

The contract for drilling the well was awarded in October, 1916, and the contract let to a well contractor who, in the opinion of the Engineer, had not qualified as an expert in well drilling, but who had the appearance of being a good, straightforward, persevering man, who would probably give the city good service if he did not meet with problems that were too much for him. The well section provided that an artesian well of about 900 ft. depth be drilled. Beginning with the 12 in. hole at the top the well was to be cased through the drift and the hole through the Niagara Limestone and the Cincinnati Shale was to be 10 in., then it was to be stepped down to 8 in. through the Galena and Trenton Limestone and the hole was supposed to stop after entering about 50 ft. into the St. Peter Sandstone.

The contractor's outfit consisted of the ordinary walking beam type of engine operated by gasoline, and he did not have any particular trouble in making satisfactory progress through the limestone and shale. The Galena Limestone, however, had pockets of sand, which appeared to open up excellent streams of water, but which offered considerable difficulty to the contractor, inasmuch as his drill would from time to time become lodged, requiring all of the power of his outfit to pull it.

Drill Becomes Lodged

At a depth of approximately 700 ft., the contractor's drill became lodged in the well, and he could not dislodge it by ordinary pulling. He had not had experience in dislodging drilling tools at that depth, nor did he have proper equipment immediately to loosen the drill. Undoubtedly, if he had had proper equipment on hand at the time of the trouble, he could have removed it, but either he was careless in not keeping his drill sharpened or the extraordinary conditions present in the well were the cause of this trouble.

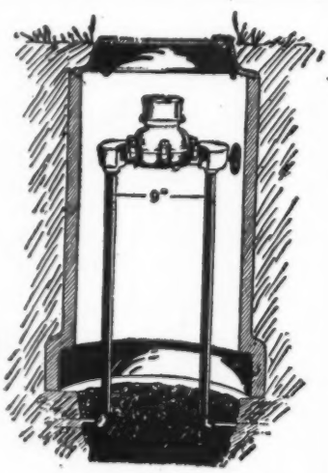
Dynamite Fails to Explode

Finally it became necessary for the City to notify the Bonding Company to take charge of the work. They employed another contractor who had had experience in dislodging drilling tools and who had a heavier outfit. This outfit was brought upon the job and it also failed to dislodge the drill. Dynamite was then recommended and the second contractor, claiming to have had experience on dislodging tools by blasting prepared a cartridge of dynamite enclosed in a water-tight tube connected to an exploding cap, which tube was small enough to drop between the drill and the side of the hole. Everything worked fine until it become time to set off the charge and it was found after several attempts, that although the cap would explode each time, the dynamite would not explode and no reasons could be offered by the contractor for its failure to operate. The opinion of other experts was then called for and there appeared to be considerable difference of opinion, some claiming that there ought not to be any difficulty in exploding the dynamite at that depth and others claiming that it could not be done.

The best explanation was offered by the Chemical Department of the American Glycerine Company of Wilmington, Del. Quoting from their letter, they stated:

> We note that you have met with failure in attempting to explode dynamite 700 ft. under water and we are not surprised at this as water pressure at that depth is quite a hard thing to cope with and your failure is due to the fact that water at that pressure, cushions, so to speak, between the different

(*Continued on page 264*)



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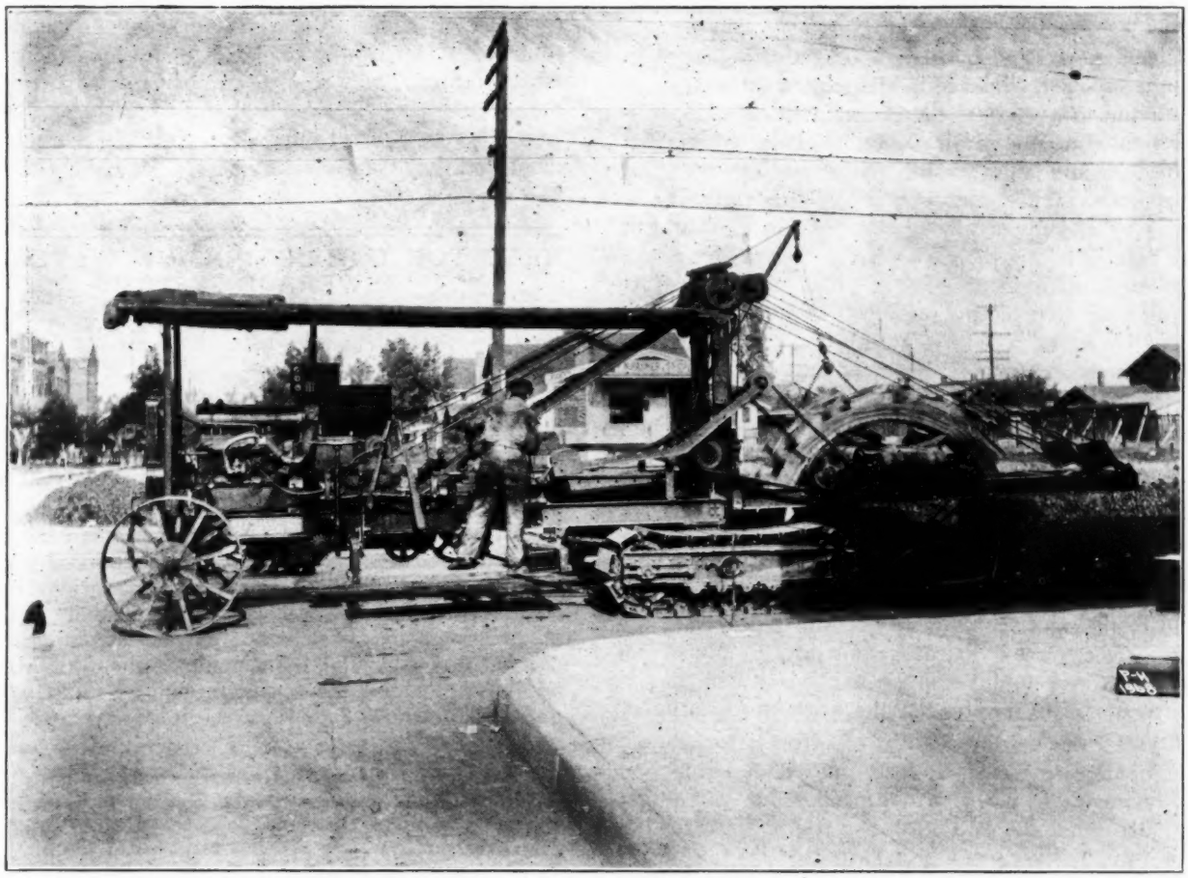

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"You see them wherever you go, and they go wherever you see them."

P&H — excavators — back-fillers - tampers

(*Continued from page 262*)

molecules of the explosive so effectively that there is not sufficient violence in the explosion of any one molecule to overcome the resistance offered by this cushion, consequently it cannot explode its neighbor molecule and as a result the explosion does not propagate. This does not affect the explosive in any way and upon moving this cushion as would be the case in taking the explosive to the surface again, the explosion would detonate the same as before being subjected to this pressure. You will find this difficulty to exist with all absorbed explosives and you cannot reasonably hope to shut out the water pressure at a depth of 700 ft. under water by means of tin or any thin material. When we get 200 lbs. pressure on a boiler, we begin to expect things, ordinarily, notwithstanding the fact that the boiler is made of heavy material.

Liquid Nitro Glycerine being an oily, compact liquid of practically 1.6 specific gravity is not affected by water pressure as are the absorbed explosives due to the fact that the water cannot penetrate the nitro glycerin; it is therefore our duty to advise you that you will find no other explosive than Liquid Nitro Glycerin, suitable for the work you mention.

We know of no source of supply for Liquid Nitro Glycerine nearer than the Aetna Explosive Company at Chicago, and it is possible you might procure some there. No doubt you are aware that this commodity cannot be transported by rail and it would be necessary to arrange to transport it by truck and if this is undertaken you want to provide especially against leakage and friction for it must be handled with care. This placed in a receptacle, leaving the top open so the water could get into the receptacle would be the proper way of arranging the material so as to lower it into the well, and since your letter indicates that you can explode electric exploders in the dynamite in the bottom of the 700 ft. well, we say that you could, of course, explode the exploders in the Liquid Nitro Glycerin, and for that reason would not consider it necessary to issue instructions regarding this matter except to ask that it be handled with due care and again repeat that you must provide well against leakage and friction.

The foregoing explanation appeared to be so reasonable that the Council decided to abandon the work altogether, for the obtaining of the necessary nitro glycerin involved an additional hazard which ordinarily cities do not care to assume. The city then decided to readvertise for bids on a new well, which was finally drilled about 7 ft. from the one giving all of the trouble.

This second well was drilled by a contractor familiar with deep well work and he successfully passed through the same strata which caused trouble to the first contractor, and although the drilling of the well was delayed about a year, the fact that the Council had awarded the contract a year in advance of the general contract, made it possible to connect up with the distributing system on schedule time.

Other small cities may profit by the experience of the city of Clinton in awarding their well contract a year in advance of the general system, for in addition to the hazard of trouble in the well, cities will find it desirable to have a water supply available for flushing their streets, which naturally will be torn up during construction. Furthermore, they will find it desirable to have their well tested before deciding upon the type of pumping equipment that they may select.

NEED FOR COMPREHENSIVE WATER AND SEWERAGE SYSTEMS

By John F. Druar, Consulting Engineer, 512 Globe Bldg., St. Paul, Minn.

If there are any two municipal utilities that are absolutely necessary in these days, it is comprehensive water and sewerage systems for all municipalities. Even in the smallest community of one or two hundred, as well as in our greatest cities, the need is urgent.

Rapidly reviewing some of these defects I have found in an investigation of some two hundred cities and villages, I find that there have been very serious faults in nearly all systems. Perhaps the engineer cannot be blamed for some of the apparent short comings, for he has had to work within the limit of the funds available and has not been able to stretch them indefinitely to meet even the ordinary requirements of good practice.

Laws Should Protect Small Cities Against Themselves

The legislatures of the different states must be blamed for not passing laws more favorable to the installation of water systems in small cities and villages. These laws should be drawn to protect a municipality against itself. No vote should be required by the citizens for bonds for such necessary improvements, but the council and other officers should be empowered to use their judgment backed by a careful report and plans and specifications of a thoroughly responsible and experienced municipal engineer for the installation of the system complete. The bond houses should be taken into consideration and the paper issued in payment for the improvement should be sold prior to the letting so that the contractor may be absolutely certain before he moves onto the work that the payments are forthcoming in cash when due. Such paper as is issued should have the full credit of the municipality behind it and draw a fair rate of interest so as to be attractive to the investor and so that no discounting of paper by subterfuge would be necessary.

In the present condition of affairs various states have different laws. In some the entire amount for which a municipality may be bonded is five per cent of the assessed valuation. The condition of the small towns of such states reflect this law. In Minnesota sewers may be installed up to practically no limit by resolution of the council and the cost assessed against the property lying in the sewer districts. This is a splendid law. It should be somewhat simplified and a law passed causing the installation of a municipal water works in the same manner but with the addition that the paper issued in payment should be made saleable; that is, more so than at the present time.

Federal Government Should Require Fire Protection and Good Sanitation

In fact, if a complete and comprehensive government study were made of the municipalities of the United States from a sanitary and fire protection standpoint, it would be found that if remedies were applied, there would be an enormous saving all along the line and it would pay to have some standard law compelling a

municipality to provide for its citizens such sanitary measures as might be necessary.

People, ever since the famous "Boston Tea Party," naturally hate to be taxed. Even when shown the necessity of improvements, certain elements of a population seem to feel that an improvement should not be made. This opposition is found among the retired farmer element as they, in many cases, have not had the improvements on the farm and maintain that what was good enough for grandfather is good enough for them. Then, there is the substantial man of affairs who has provided a private water and sewerage system at an expense of four or five hundred dollars, or even more, and he becomes opposed to it through selfishness and personal loss of his own system. He is too narrow minded to look to the welfare of his neighbors.

As such improvements generally call for a five-eighths vote to carry, it is at once apparent that if there is much opposition, the project will fail.

The near-sighted policy of the people is seen in not having had these utilities years ago for the cost is not great and the benefits many. The people fail to realize that the cost of building and maintaining an unsightly, crude, fly-breeding nuisance in the back yard, perhaps in close proximity to their dug well, and the cost of cleaning it several times a year, to say nothing of the periodical visits to this place of horrors in all kinds of weather, in sickness and in health is a thing they can not afford to continue even at great cost.

Economy of Sewerage Systems

As a matter of fact, an adequate sewer system can be installed in the average city or village of from five hundred to five thousand inhabitants by a direct assessment against the property abutting on the sewer in even these times for from $1.50 to $2.00 per foot front. In the last year, the cost on my work has been from $49.50 to $104.75 for a lot with a fifty-foot frontage. This amount can be paid in ten annual installments if it is desired with six per cent interest on deferred payments, or it can be paid up in full at the time the assessment is made. Thus at a cost of $100 or less per fifty foot lot, one may be relieved for all time of further cost or expense for the disposal of physical wastes and cellar drainage, as well as of the washing and cleaning water, etc.

Problem of Water Supply

Now the water problem is about the same. A community to be healthy and clean must have an adequate supply of clean, clear, pure and reasonably soft water in inexhaustable quantity, pure, as protected against contamination, and at a point where it will be economical to deliver it to the storage provided. In many cases, it is extremely difficult owing to the surrounding conditions to provide such a supply. Surface sources such as lakes, rivers and creeks are least satisfactory, as they all require treatment to protect the users against disease, and carelessness of the cleanliness of a water supply has sent a great many people to their death.

The problem of supply is one that must be given very careful consideration. If a large storage system is to be maintained, it is not necessary to have a large capacity source of supply, and on the other hand, if there is no opportunity for storage, then the per minute supply must be great. To supply the domestic requirements is not difficult, but in many cases, it is extremely difficult to store or provide by other means enough water to meet the standard requirements for fire protection as required by the National Board of Fire Underwriters. On this problem hinges the insurance rate of the municipality and

PROOF
THAT
THE NATIONAL METHOD
Cleans Water Mains

Note the number of contracts the following cities have entered into for **Water Main Cleaning.** These cities recognize the **economy, efficiency** and **necessity** of cleaning water mains by the **National Method:**

	Contracts		Contracts		Contracts
Boston, Mass.	5	Jersey City, N. J.	3	Rochester, N. Y.	7
Brooklyn, N. Y.	4	Little Rock, Ark.	3	St. John, N. B.	3
Cambridge, Mass.	5	Louisville, Ky.	5	St. Joseph, Mo.	3
Charleston, S. C.	4	Meridian, Miss.	3	St. Louis, Mo.	6
Cincinnati, Ohio	10	Newport, Ky.	5	Salt Lake City, Utah	5
Dayton, Ky.	3	Newport News, Va.	4	Shreveport, La.	3
Far Rockaway, N. Y.	5	Pittsburgh, Pa.	4	Uniontown, Pa.	3
		Suffolk, Va.	3		

Twenty-five cities have entered into second contracts and **one hundred** cities have entered into at least one contract for this work, in addition to the cities named above.

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the savings that can be made in premiums for the people of a community.

Thus a carefully studied source of supply, storage and distribution system laid out for the future as well as for the present needs is the only true solution of a water problem.

The source of supply varies. It may be from deep wells, pumped to a surface reservoir by means of compressed air or deep well pumps. From this point, it can be relayed by electrically or steam driven pumps of greater mechanical efficiency to a reservoir on a hill of enough elevation to give a gravity pressure, or it may be necessary to build an elevated structure for the purpose of obtaining the same pressure. The supply may be obtained from shallow wells or drive points which should pass through a clay strata first so as to protect the underlying water from contamination from the surface. Again, the supply may be obtained from shallow wells of large diameter placed adjacent to a lake or river, the water being supplied by infiltration from the gravel strata.

In different parts of the United States, there is to be found an artesian flow, which, in many cases is strong enough, i. e., has enough head to produce the necessary pressure of 40 to 50 lbs. on the distribution mains and which allows a reservoir to float on the line at a given height. This may be controlled so as to keep the reservoir full at all times. For large works, sometimes the surface lakes of a territory are carefully protected and these with gravity flows become the reservoir system, but the surface supplies should be carefully treated and perhaps filtered before being sent into the distribution mains.

The problem of the supply of larger cities requires an enormous amount of work and an everlasting study for future development as is shown in the case of New York City and any of the largest cities in the country.

Distribution System

The distribution system should be of the gridiron type with numerous valves for the purpose of utilizing the maximum efficiency of the lines at all times even in the case of breaks. The reservoir or other source of supply should be tied into the distribution system with two or more feeders if possible. All pumping equipment should be in duplicate with ample capacity in the duplicate units to take care of breakdowns.

In smaller systems, it is possible to design a closed system with pressure tank operation, but while I have designed many of these systems successfully, I would far rather have a gravity system as it is then not necessary to place all your reliance on the mechanical equipment. Very often pumps are operated by current obtained through a transmission line and if a breakdown occurs, and there is no gravity storage, the whole municipality might be destroyed through lack of pressure, in case of fire.

In the larger cities direct pressure is maintained on a closed circuit by means of pumps which by-pass such amount of water as is not being used in the system and a steady pressure is maintained in that way. Again special high pressure fire mains for river, fresh or salt water are used and the pressure and water is applied to the mains in case of fire only.

There are many combinations of the above that can be made applicable to the distinct problem, and in a short article it is impossible to touch on all of them. Suffice it to say that no town should be without a carefully thought out system, designed in such a way that it will not be a burden to maintain but one that will afford ample protection in case of fire, afford a good pure supply for domestic use and give all the citizens the advantage of the use of water.

Water Systems Are Economical at Present Prices

The cost of a water system at this time is high due to, primarily, the advance in the price of cast iron pipe. When one looks at the cost of a well in the door yard with an uncertain quality of water, which of necessity has to be pumped and carried in all kinds of weather and the cost of the installation of the pump and well and then finds that the cost of a water system in front of his property good for practically all time if properly installed for a 50-foot lot would be between $75 to $90 and that he can rely on it for fire protection as well and can obtain a ton of clean, pure, clear water drawn into his kitchen sink for probably less than 10 cents a ton, he is very likely to ask someone to kick him for being such a dolt as not to have discovered it before.

To be sure, he has to pay for a connection from the city main to his house for both water and sewer service and also for bath room fixtures, but the charge for connection to the house is but nominal while he can have as cheap or expensive fixtures in his house as he could wish.

I have endeavored in a short article to cover much ground and have tried to set forth the difficulties of the installation of water and sewers for the average municipality so that the layman as well as the non-technical city official may appreciate the vital importance of the subject.

How under the sun municipalities can and have done without water and sewer when they are vitally in need of them is more than I can understand.

Aside from the disposal plant or outlet for sewers and the well, pumping equipment and storage for water which is usually paid out of a bond issue, the individual lot owner would only pay about $200 for both water and sewer and could pay this at the rate of $20 per year for ten years. Such a system would be good for the next 60 or 70 years and it is up to the municipal engineer to go forth and educate the legislatures and public to the necessity of uniform laws for the purpose.

REMOVAL OF SULPHUR AND IRON FROM GROUND WATER IN OHIO

By George Champe, Consulting Engineer, 610 Nasby Building, Toledo, Ohio

The ground water supply of Northwestern Ohio is more or less charged with a sulphur and an iron content, the former causing an objection to the taste and odor of the water and the latter causing the deposit of the iron compound and a restriction of the carrying capacity of the distribution pipes and the coloration of plumbing by red water.

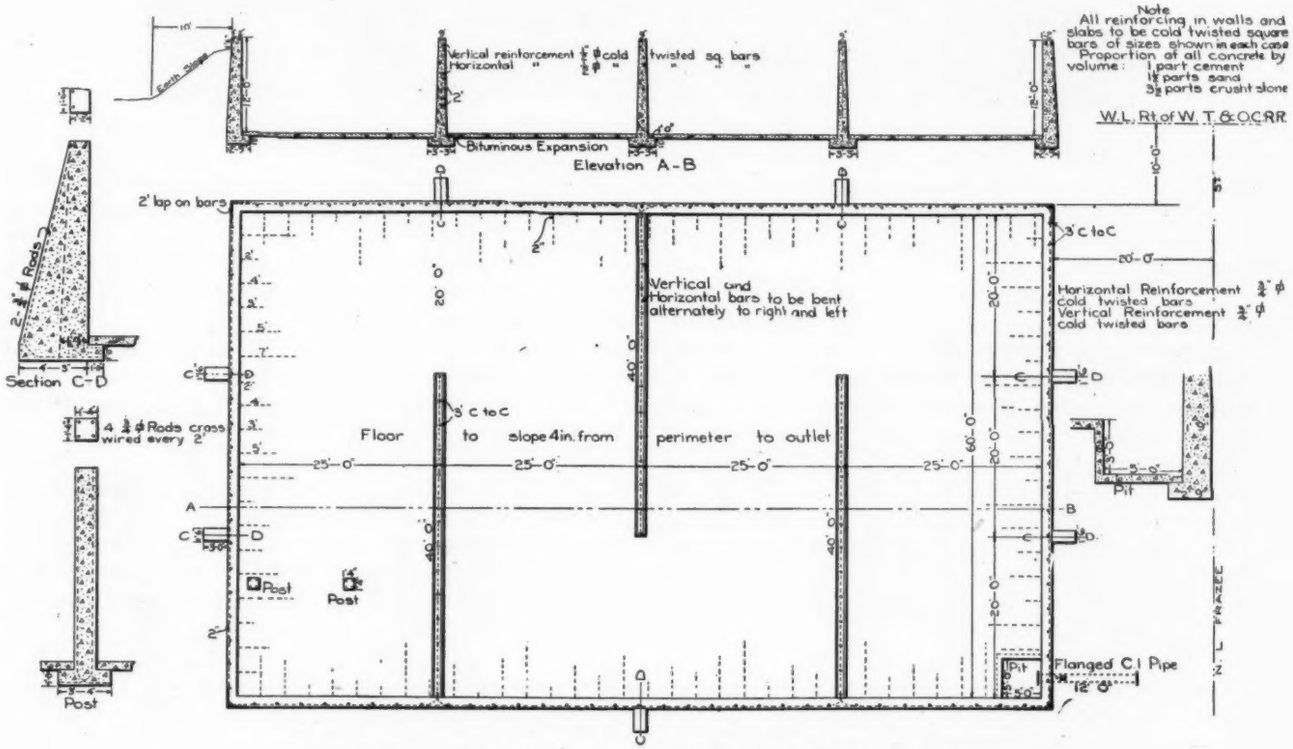
Reducing Sulphur Content at Leipsic, Ohio

Several years ago when the writer designed a concrete water storage reservoir for Leipsic, Ohio, an attempt was made to reduce the large sulphur content by conducting the well supply to the center of the circular reservoir and thence vertically to a point where it was discharged and passed by gravity to the reservoir beneath, through three circular trays, each perforated with ¼-in. holes, 1 in. apart. The trays were surrounded with wire

mesh of sufficient openings to afford a free circulation of air, but not large enough to permit the entrance of small birds. The original trays were constructed of steel boiler plate but were soon after replaced with wooden trays which have shown no evidence of deterioration, and establish the economical type of aerator of a water supply. Provision was made for discharging the material deposited on the bottom of the reservoir, periodically, through a sewer outlet.

Reducing Iron Content at Minster, Ohio

Afterwards, in designing a rectangular storage reservoir at Minster, Ohio, the aerator for the reduction of the iron content was placed at the extreme end from the outlet to the pump, and the supply was distributed over the uppermost tray through perforated horizontal galvanized iron pipes so that the water fell uniformly


Note
All reinforcing in walls and slabs to be cold twisted square bars of sizes shown in each case
Proportion of all concrete by volume: 1 part cement, 1½ parts sand, 3½ parts crushed stone
Vertical reinforcement ¾ ϕ cold twisted sq. bars
Horizontal " ¾ ϕ " " "
Bituminous Expansion
Elevation A-B
W.L. Rt of W. T. & O.C.R.R.
2' lap on bars
3' c to c
Vertical and Horizontal bars to be bent alternately to right and left
Horizontal Reinforcement ¾" ϕ cold twisted bars
Vertical Reinforcement ¾" ϕ cold twisted bars
Section C-D
4 ¾ ϕ Rods cross wired every 2'
Floor to slope 4 in. from perimeter to outlet
25'-0"
Pit
Post
Flanged C.I. Pipe
12" ϕ

DETAILS OF WATER STORAGE RESERVOIR AT BOWLING GREEN, OHIO.

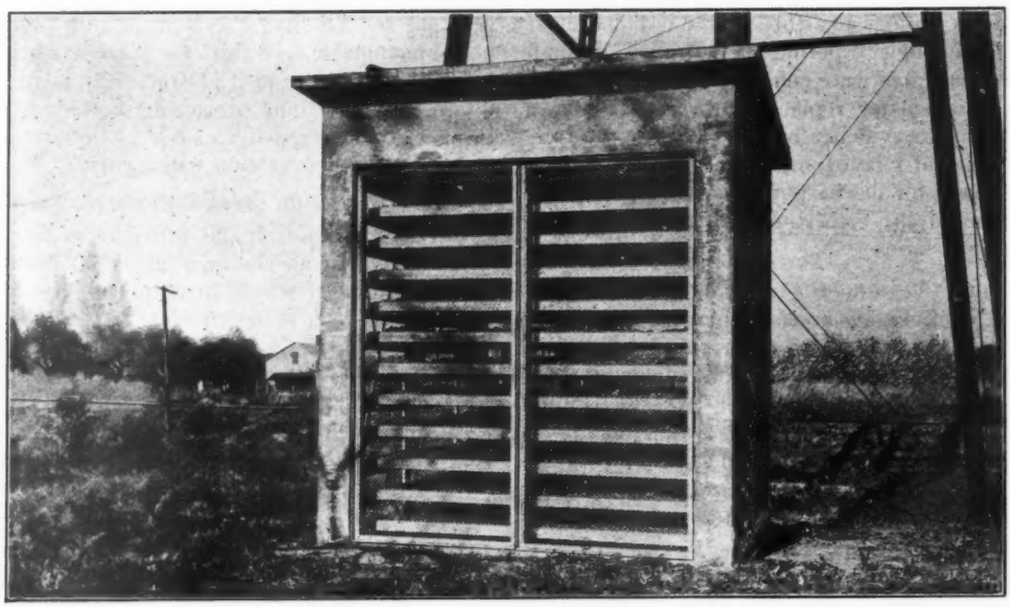
over the area of the upper tray. Twelve square trays were built, each consisting of a galvanized steel frame, with bottom of galvanized iron mesh, this in turn covered with 4 ins. of Connellsville coke, crushed to a diameter of 2 ins. An air space of 4 ins. was left between the bottom of each tray and the coke beneath. Provision was made for the removal of the trays and the replacing of the coke, but not more than two changes have been necessary since the installation in 1912. Twice yearly the deposit is washed from the bottom of the reservoir through the storm water sewer connection.

Reducing Sulphur and Iron Content at Maumee, Ohio

In the installation of the municipal water works system at Maumee, Ohio, an aerator of similar form to that at Minster was constructed for the reduction of both the large sulphur and iron content. In this case there is an entire elimination of the sulphur with approximately 75 per cent reduction of the iron, or to a point where it is not objectionable. In this case there has been no replacement of the coke, and it is practically in its original condition of 1915. The process is mechanical, the purpose being to add as much free air to the water as the economical gravity operation will secure.

Reducing Sulphur at Bowling Green

At Bowling Green the water from five supply wells showed sulphur to the amount of 70 parts per million. Here the aerator was constructed of creosoted hemlock, and consists of a series of 15 trays, each 12 ft. by 12 ft. square. Hemlock was decided upon on account of the impossibility of securing a galvanized steel frame in time for the season's operation. The bottoms of the trays are ½-in. mesh, No. 15-gauge wire, heavily galvanized after weaving, and covered with 3 ins. of chestnut size fresh Connellsville 72-hour coke. Distribution from the discharge pipe above the aerator is secured by an extra wooden-bottom tray, perforated with ½-in. holes. After one season's operation the coke on the trays is in practically its original condition. The sedimentation and storage reservoir is of 500,000-gal. capacity to overflow, being 60 ft. by 100 ft. in area, and 12 ft. deep, depressed 4 ft. into the earth, and banked on the outsides with excavated material. All concrete in floors and walls, consist of 1 part cement, 1½ part cement, 1½ part sand, and 3½ parts crushed stone, varying in size from ¼ to ¾-in. Sufficient water was used to secure a mixture that would flow in the forms with the least possible excess of water, and special care was exercised to prevent sloping surfaces in the fresh concrete that would cause a separation of the coarser material, and result in seeping walls. Three baffle walls, staggered, and extending to within 20 ft. of the opposite outside wall and to the full height



VIEW OF AERATOR AT MAUMEE, OHIO.

of the reservoir, provided for sedimentation over the entire reservoir area. At the close of the first season the floor of the reservoir was covered with a thin layer of light-grayish deposit.

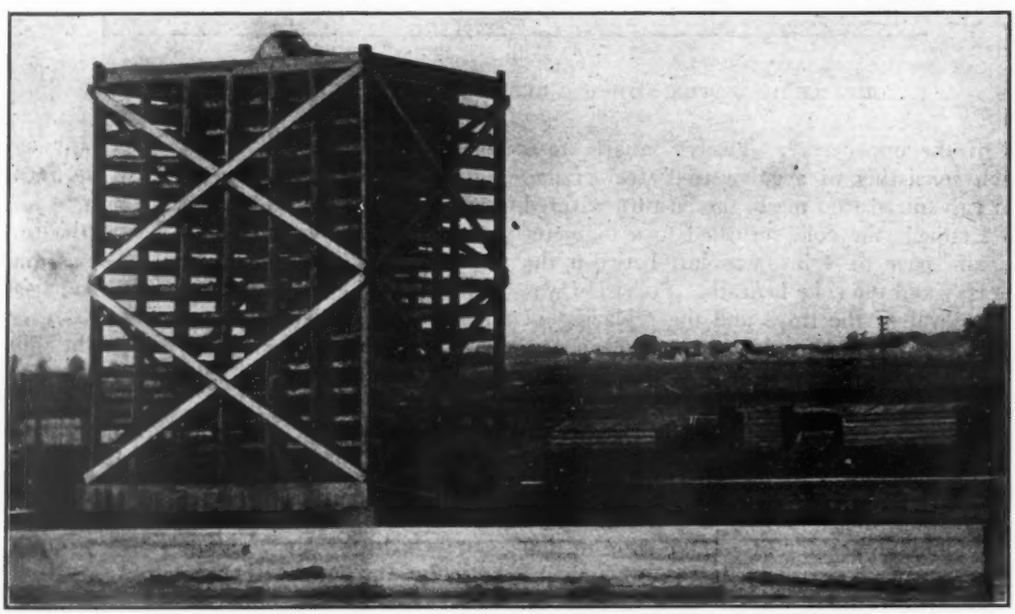
USING MOTION PICTURES IN THE DETROIT STREET RAILWAY BOND ELECTION

Motion pictures were successfully employed at Detroit recently in helping to win the election held to vote on the issuance of fifteen million dollars in bonds for the improvement of the street railway system of that city. The city proposed to take over the present street-car system and to build many new lines and the voters were asked to provide the money. As usual, there was considerable opposition to this project.

Shortly before the election it was decided to utilize moving pictures and the Rothacker Film Manufacturing Company of Chicago was selected to make the film. The pictures were exhibited in the Detroit theaters shortly before the election. Up to the time the pictures were introduced into the campaign the advocates of the bond issue were doubtful as to the result of the election. The election carried, however, by a safe margin and many Detroit citizens stated that in their opinion the pictures proved to be the deciding factor.

The pictures consisted largely of animated drawings visualizing the present Detroit situation as well as the proposed improvements. Cartoons of street-cars were shown moving across the screen to illustrate the roundabout way in which some citizens must now travel in going to work. The waste of time was emphasized and

(*Continued on page* 271)



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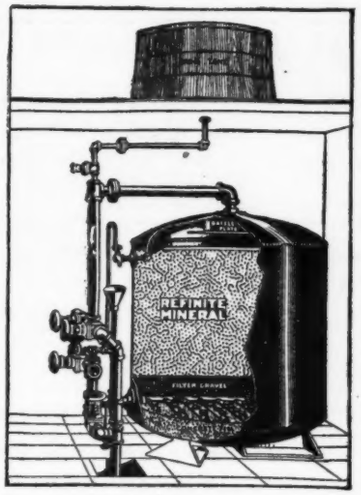

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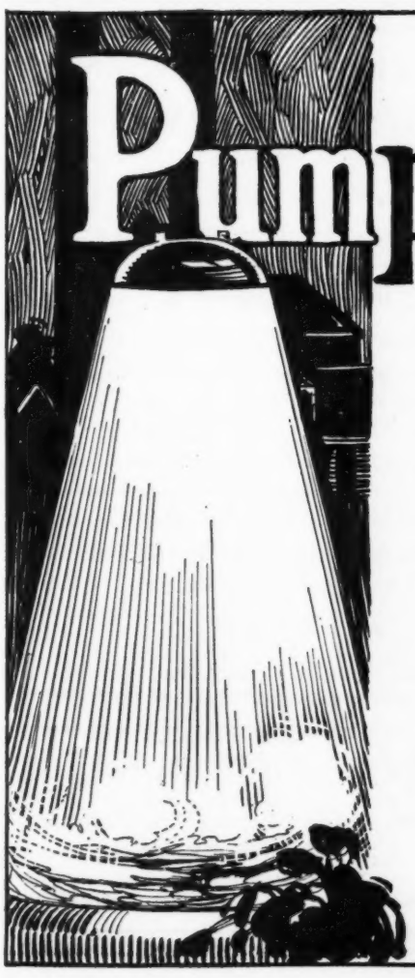

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(*Continued from page 268*)

attention was called to the number of transfers many workers now have to make in going to and from work. Of course, these matters were quite familiar to citizens of Detroit, but when these cartoons were shown on the picture screen they lead to a determination to correct the existing conditions.

Between animated drawings of the present system there were shown on the screen, at frequent intervals, Detroit street scenes showing the present crowded condition of the cars. Then followed animated drawings of the many new lines which fifteen million dollars would build. These new lines will take the citizen, regardless of his place of residence, to his work in most cases without even one transfer.

The success of this picture was such that a street railway company in another city is now planning to have the same film company make a picture for its needs. At the present time this railway company is not receiving a sufficient fare to maintain the present service, to say nothing of building the new lines which the city needs and wants. This street railway company aims to show the citizens of its town what a fare increase would enable it to give in the way of improved service.

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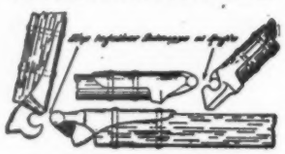

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CONSTRUCTION NEWS AND EQUIPMENT

A MOVEMENT TO DECREASE THE HAZARDS IN THE CONTRACTING BUSINESS

Certain proposed contract provisions, designed to take some of the "gamble" out of the contracting business have been brought out recently by a strong committee of the Associated General Contractors of America. The provisions number 16, and it is recommended that they be included in all future contracts. Criticisms and suggestions are invited from contractors, engineers, manufacturers and others interested in the subject.

The Hazards of Contracting

An analysis of income tax returns shows that contracting is the most hazardous industry in the country. They show that the amount of loss for every dollar of profit made by construction corporations is eight times as great as it is in manufacturing, agriculture, or personal service corporations; five times as great as in transportation and public utility corporations; over three times as great as in mining and quarrying; and nearly twice as great as in banking.

The reasons for this condition are due to the unusual number of doubtful elements in construction with which a contractor must work. It is unnecessary to enumerate them. They are all too familiar. It is sufficient that the more such uncertainties can be eliminated, the lower will be the costs of construction to the owner, the more satisfactory will be the relations of the architect the engineer and the contractor, and the more will contracts be awarded on a basis of skill, integrity and responsibility. Never was this more true or action on it more needed that at the present time.

From the very nature of construction many of these uncertainties can never be eliminated. They must either be assumed by the contractor or the owner. Some which are now assumed by the contractor ought by right to be assumed by the owner. Other uncertainties may be eliminated entirely to the advantage of both parties. The improvement of present contract provisions is one of the simplest solutions for this problem.

It was with these thoughts in mind that the Committee on Contracts of the Associated General Contractors of America, during the past year made a study of 113 different forms of contracts of various types. The committee is not prepared at this time to submit a complete form of contract embodying every position which should be included in a good contract. The members have, however, approved the following provisions which they recommend be included in every contract made by members of the Associated General Contractors of America. Additional provisions will be submitted from time to time.

Proposed Contract Provisions

1. Action on Bids—Bids should be submitted with the provision that they must be acted upon within a reasonable time.

2. Freight Rate Changes—Bids should be submitted on the basis of existing freight rates, with the provision that in case a change in rates should occur between the time bids are received and the date fixed for the completion of the contract, the contract price should be increased or decreased accordingly.

3. Wage Scale Changes—Bids should be stated and be submitted on existing wage rates, with the provision that the contract price shall be increased or decreased in accordance with any change in such rates before the date fixed for the completion of the contract.

4. Material Price Changes—Bids should be submitted on the basis of existing prices for materials f. o. b. the producer's plant or distributor's yard, with the provision that the contract price shall be increased or decreased in accordance with any change in such price that takes place within the time allowed the contractor to purchase and fabricate his materials.

5. Monthly Estimates—Monthly estimates should include materials delivered and suitably stored as well as materials incorporated in the work.

6. Partial Payments—Certificates should be prepared and delivered to the contractor between the first and tenth day of each month, showing the proportionate part of the contract price earned during the preceding month. These certificates should be paid by the owner by the tenth day of the month. Interest on deferred payments should be paid the contractor at the prevailing rate.

7. Contractor's Right to Stop Work—Under the following conditions the contractor should have the right to stop work or terminate the contract upon three days' written notice to the owner and the architect, and recover from the owner payment for all work executed and any loss sustained upon any plant or material and reasonable profit and damages:

(a) If the work should be stopped under an order of any court, or other public authority, for a period of three months, through no act or fault of the contractor or any one employed by him;

(b) If the architect or engineer should fail to issue the monthly certificate for payment in accordance with the terms of contract;

(c) If the owner should fail to pay the contractor, within seven days of its maturity and presentation, any sum certified by the architect or engineer or awarded by arbitration.

(d) If the owner does not permit the contractor to proceed with construction within a reasonable time after signing the contract.

8. Retained Percentage—The retained percentage

Printed as insert to Municipal and County Engineering, Chicago, Ill., June, 1920.

should be based on 100 per cent. of the work performed and should never exceed 10 per cent. When the amount retained reaches a total sum, which shall be mutually agreed upon by the owner and the contractor, no further reduction from payments should be made.

9. Surety Bond—Where a surety bond is given, it should be reduced at agreed intervals so as to cover thereafter only that portion of work then uncompleted.

10. Penalty Clauses—Wherever any provision is incorporated in the contract for a penalty against the contractor (including liquidated damages), there should also be inserted provision for a bonus of like amount.

11. Acts of God or Public Enemy—The contractor should not be held liable for results arising from the acts of God or a public enemy.

12. Time Allowed for Completion of Work—The time allowed for the completion of the work should be based on "weather working days" instead of an elapsed time, and, if necessary, allowance should be made for time spent in performing unproductive work made necessary by floods or other natural causes beyond the control of contractor.

13. Inspection—Where practicable, materials should be inspected at the source so that costly delay may not result from the rejection, at the site of the work, of materials furnished in good faith by the contractor.

14. Force Account Work—Payment for force account work should be made on the basis of the total actual costs of the work, including the actual labor and material costs, rental on equipment, liability insurance, etc., plus a reasonable percentage to cover overhead and profit, total to be not less than 15 per cent.

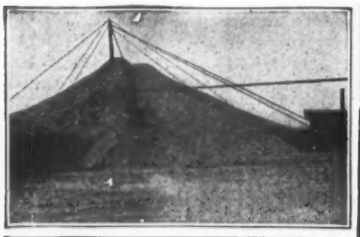
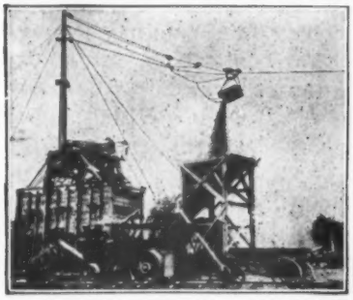
15. Change in Quantities—In case the actual quantities of any item in a unit price contract are less than the estimated quantities by more than a certain fixed per cent. the unit price paid the contractor for that item should be increased by an amount to be agreed upon. Similarly, a decrease in the unit prices should be made in case the quantities are increased over the estimate by more than a certain fixed per cent.

16. Arbitration—In no case should the engineer or architect be made the final judge as to the interpretation of the drawings and specifications or the performance of the contract. All decisions and interpretations should be subject to prompt arbitration at the choice of either party to the dispute.

Personnel

The personnel of the committee formulating these proposed contract provisions is as follows:

J. W. Cowper, Chairman, John W. Cowper Co., Buffalo, N. Y.; Arthur Bent, Bent Brothers, Los Angeles, Cal.; M. L. Cunningham, Municipal Imp. Co., Oklahoma City, Okla.; Avery Brundage, Chicago; V. T. Goggin, Fred T. Ley & Co., Inc. Springfield, Mass.; L. S. Oakes, Winston Brothers Co., Minneapolis, Minn.; J. W. Rollines, Holbrook, Cabot & Rollins, Corp., N. Y. City. and E. Stanley Holland, Bates & Rogers, Construction Co., Chicago.

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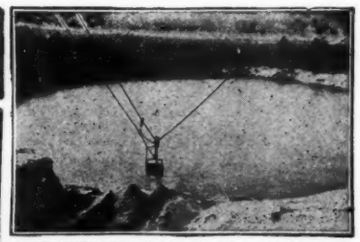

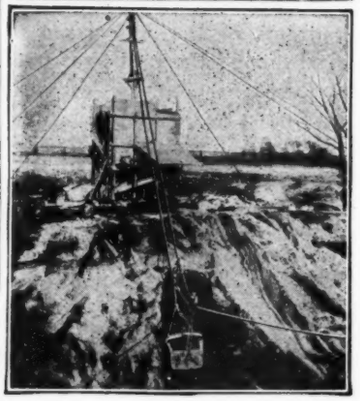

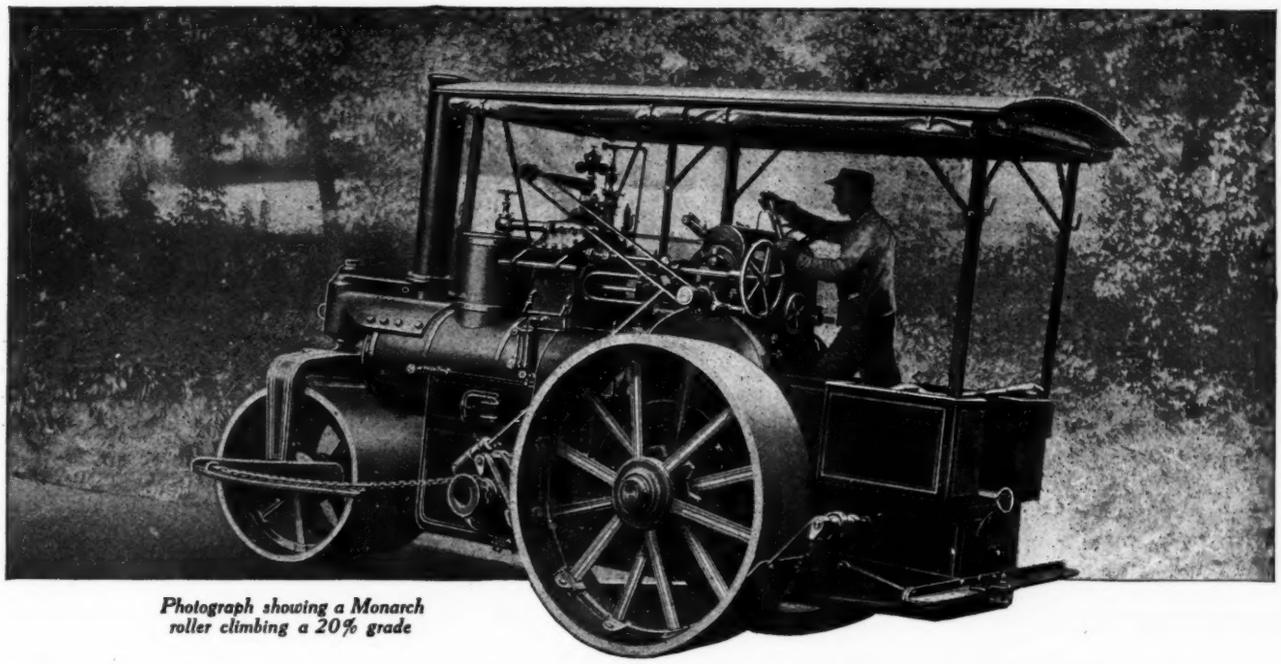

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CHOOSING THE TYPE OF PUMP AND THE SIZE OF PIPE ON CONSTRUCTION JOBS

By R. E. S. Geare, General Sales Manager, The T. L. Smith Co., Chicago, Ill.

Jobs where the hourly payroll runs into hundreds of dollars have been known to be held up hours merely because of the eccentricities of that all important, but seemingly insignificant pump. Yet delays which have cost the entire price of the pump at each occurrence have not seemed to impress upon the contractor the importance of actually knowing in his own mind what to look for in a pump.

Preventing Pump Shutdowns.

A simple method of guarding against these costly shutdowns is suggested as follows:

Look your pump over for mechanical defects at least once a week. A new bolt or nut may avert a hundred-dollar shutdown later.

Oil it regularly.

Be sure that the weight of the discharge line is not borne by the pump. Brace it or support it firmly.

With a force pump, place a foot valve with drainer in the suction line submerged in the source of water and valve in the discharge line.

In the case of a centrifugal pump, a hand or steam primer should be provided which should be connected to the top priming hole in the casing. Fill the casing with water *before* starting the pump.

Before you start on a new job figure out whether your present pumping equipment is capable of delivering the required capacity against your total lift and friction head.

Choosing a Pump.

This last suggestion is important—vital. There has always been something mysterious about the actual figuring of pump capacities which has prompted contractors to pass up all attempt at arriving at actual and definite figures. What would we think of a contractor who just blindly picked out a concrete mixer without regard to his requirements and then proceed to dump ingredients promiscuously into the drum without rhyme or reason, and expect to get satisfactory results? He would be eliminated from the ranks of the contractors very soon.

Yet did you ever stop to consider that this is about the basis on which a great many pumps are bought, even among successful contractors? If the contractor does not know about pump capacities or friction heads he asks somebody, anybody usually, or worse still, he guesses at it. Why does this condition exist? Is the average contractor a poor business man? Decidedly not, the $500,000,000 industry in which some 70,000 men are making money proves that. Is he naturally shiftless or inaccurate about such things? The idea is absurd in view of the great feats of construction he has accomplished. Here is undoubtedly the reason: the contractor is a busy man, he is doing big things and thinking big thoughts. That pump seems like an insignificant thing, a mere detail, and so it is if it is properly selected. But it assumes enormous significance when it fails to function in the manner intended.

Don't Forget Pipe Friction.

Recently a contractor secured a paving contract. Immediately he began buying his equipment. The last two items were 15,000 ft. of 2-in. pipe and a pump, in the order named. He had an elevation of only 60 ft. but a 15,000-ft. run to the job, and he wanted 45 gals. per minute at the end of the pipe line. His lift was only 60 ft., but his friction head was over *750 ft.* Think of wasting twelve times the actual head in friction. The pressure was so great that the pipe couldn't even stand the strain and he was forced to install two heavy duty pumps—one to pump half way to a tank and another to relay the water the remainder of the distance.

The moral is this: If he had only figured the friction head he would have discovered that by installing larger pipe he could have gotten the desired amount of water with one small duty pump, instead of two heavy duty pumps, and at a considerable saving of time and money.

Another example of the danger of guess work in getting a correct supply of water is illustrated by an instance which recently came to the writer's attention. In the case in point the contractor located a splendid supply of water at a distance of about 1,000 ft. from his job with a nice incline running down toward him. He thought this slope was decidedly fortunate for him—as indeed it was, had he understood conditions a little more thoroughly.

He decided to let gravity do the work and promptly installed 1,000 ft. of 1-in. pipe to carry the water to the job. When the line was completed he was amazed to find nothing more than a mere trickle of water coming through the end of the pipe. He had neglected to account for the friction which developed as the water passed through the pipe and out down the flow.

He was finally forced to install a pump actually to force the water down the incline. His only other alternative would have been to tear up all of his 1-in. pipe and replace it with another line of larger diameter.

This particular case was not a pump problem at all, or at least it should not have been. A clearer understanding of the subject would have saved this contractor the price of many pumps.

It is very simple to get just the exact pump for each particular job, and it is the object of this article to give in brief form a few simple directions and tabulations which will enable any pump user to figure exact size of pump necessary.* If this information is not already available in convenient form we would suggest that the contractor file this data where it can be referred to when the occasion arises.

The Uses of Various Pump Types.

At the start it might be well to explain the uses to which each particular type of pump is best adapted This may seem elementary, but it has been observed that inefficient operation is frequently traceable to the wrong kind of pump being used for the work. Diaphragm or splash pumps are designed for pulling purposes only. They have no pushing power and therefore their scope of operation is limited to the suction head only. This type is generally used to empty sewers, ditches, etc. Its lift is generally limited to a maximum of 25 ft.

Centrifugal and plunger type pumps are to be used where a lift and push are necessary. These two pumps

* These directions and tabulations are taken from the book "Never Failing Water," issued free by the T. L. Smith Company, 473 Old Colony Bldg., Chicago, Ill.

TABLE I—FRICTION OF WATER IN WROUGHT AND CAST IRON PIPES

Frictional heads at given rates of discharge in clean wrought iron pipe. (Inside Diam.) for each 100 feet of length.

U. S. Gal Per Minute	U. S. Gal. Per 24 Hours	¾ In. Pipe Friction hd.		1 In. Pipe Friction hd.		1¼ In. Pipe Friction hd.		1½ In. Pipe Friction hd.		2 In. Pipe Friction hd.		2½ In. Pipe Friction hd.		3 In. Pipe Friction hd.	
		Feet	Lbs.	Feet	Lbs.	Feet	Lbs.	Feet	Lbs.	Feet	Lbs.	Feet	Lbs.	Feet	Lbs.
5	7200	7.59	3.30	1.93	.84	.71	.31	.27	.12	....	....	....	....	....	....
10	14400	29.90	13.00	10.26	3.16	2.41	1.05	1.08	.47	....	....	....	....	....	....
15	21600	66.01	28.70	16.05	6.98	5.47	2.38	2.23	.97	....	....	....	....	....	....
20	28800	115.92	50.40	28.29	12.30	9.36	4.07	3.81	1.66	....	....	....	....	....	....
25	36000	.....	....	43.70	19.00	14.72	6.40	5.02	2.62	1.18	.51	....	....	....	....
30	43200	.....	....	63.25	27.50	21.04	9.15	8.62	3.75	2.09	.91	....	....	....	....
35	50400	.....	....	85.10	37.00	28.52	12.40	11.61	5.05	2.76	1.20	....	....	....	....
40	57600	.....	....	110.40	48.00	37.03	16.10	14.99	6.52	3.68	1.60	1.19	.52	....	....
45	64800	.....	....	.....	....	46.46	20.20	18.74	8.15	4.60	2.00	1.49	.65	....	....
50	72000	.....	....	.....	....	57.27	24.90	23.00	10.00	5.61	2.44	1.86	.81	.80	.35
75	108000	.....	....	.....	....	129.00	56.10	51.52	22.40	12.23	5.32	4.14	1.80	1.70	.74
100	144000	.....	....	.....	....	.....	....	89.70	39.00	21.75	9.46	7.36	3.20	3.01	1.31
125	180000	.....	....	.....	....	.....	....	....	....	34.27	14.90	11.24	4.89	4.57	1.99
150	216000	.....	....	.....	....	.....	....	....	....	48.76	21.20	16.10	7.00	6.55	2.85
175	252000	.....	....	.....	....	.....	....	....	....	64.63	28.10	21.75	9.46	8.85	3.85
200	288000	.....	....	.....	....	.....	....	....	....	86.25	37.50	28.68	12.47	11.54	5.02
250	360000	.....	....	.....	....	.....	....	....	....	....	....	45.21	19.66	17.84	7.76
300	432000	.....	....	.....	....	.....	....	....	....	....	....	64.53	28.06	25.76	11.20
350	504000	.....	....	.....	....	.....	....	....	....	....	....	....	....	34.96	15.20
400	576000	.....	....	.....	....	.....	....	....	....	....	....	....	....	44.85	19.50
450	648000	.....	....	.....	....	.....	....	....	....	....	....	....	....	57.50	25.00
500	720000	.....	....	.....	....	.....	....	....	....	....	....	....	....	70.84	30.80

fill somewhat the same purpose, yet their distinction is clearly defined.

Where a small quantity of water is required at a high pressure the plunger type should be used, as under these conditions the efficiency of this type of pump is very high. If a large quantity of water is required the centrigal type of pump will operate with good efficiency at a comparatively low head.

The basic consideration in figuring pumping capacities and heads, is friction. Just as any two metal surfaces coming in contact with each other develop friction so does water passing through a pipe and rubbing the sides

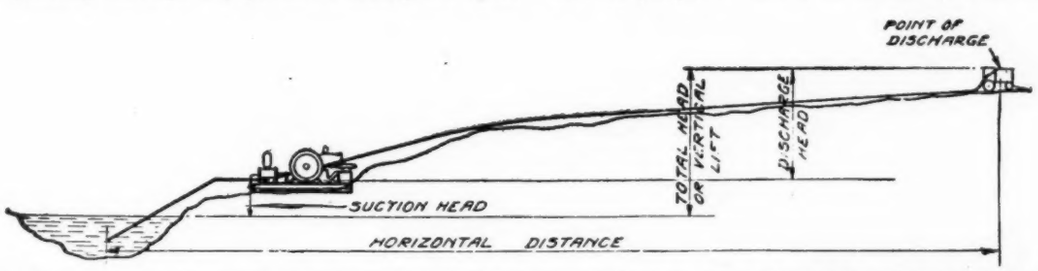


DIAGRAM ILLUSTRATING THE HYDRAULIC ELEMENTS INVOLVED IN PUMP AND PIPE LINE COMPUTATIONS.

develop the same condition. The friction acts as a retardant which keeps the water from flowing freely through the pipe, and it is the function of the pump to supply a force at one end of the line which maintains the flow at the other.

To explain clearly the power necessary to overcome this feature of friction let us assume that we wish a flow of water at the rate of 100 gals. a minute. If we lay a 2-in. pipe for a distance of 100 ft. and connect one end to a big tank of water we shall receive a flow of water in proportion to the height of the water in the tank. In order to exert sufficient pressure upon the line to deliver the flow at the necessary rate of 100 gals. per minute the height of the water in the tank will have to be exactly 21.37 ft. above a line from the center of the pipe. If the water in the tank were to recede to, say 12.23 ft., the pressure would have correspondingly diminished to a point where the friction in the pipe permits a flow of only 75 gals. a minute. On the other hand, if the amount of water in the tank was increased to 34.27 ft., the flow would become increased to 125 gals. per minute. Intermediate pressures will, of course, vary the flow proportionately. Complete friction tables are given herewith, see tables I and II.

On a line where it is impossible to get this pressure to push the water through the pipe by natural means, such as outlined above, it is necessary to attach a pump for the purpose. Here, as in the case of the water tank, as the pressure exerted by the pump is increased the flow of water is correspondingly increased.

To figure the horse power neeessary, refer to the friction tables given and proceed as follows:

Example of Necessary Computation.

We wish, for example, to elevate 100 gals. of water per minute to an elevation of 100 ft. through 200 ft. of 2-in. pipe with two elbows and one valve in the pipe, the pump having an efficiency of 60 per cent.

Example:

100 (Elevation)
+ 43.5 (Friction in 200 ft. 2-in. pipe — double the friction in 100 ft. 2-in. pipe.)
+ 3 (Friction in two elbows.)
+ 1.7 (Friction in one valve.)

100 + 43.5 + 3 + 1.7 = 148.2 total head.

TABLE II—FRICTION OF STANDARD PIPE FITTINGS

The following equivalent length of straight pipe should be added for each fitting in figuring friction.

Size of Fittings	¾	1	1¼	1½	2	2½	3	4	5	6
Elbows	5	5	6	7	7	10	12	18	25	30
Return Bends	10	10	12	14	14	20	24	36	50	60
Globe Valves	6	6	7	8	8	12	24	30	40	50

Owing to the burr (caused by cutting the pipe with wheel cutter) obstructing the flow in the smaller pipes, it is advisable, unless the burrs are reamed out, to multiply the above figures, by 3 for ¾ and 1 inch fittings and by 2 for 1¼, 1½ and 2 inch fittings.

100 (Gallons per minute.)
× 8.33 (Weight of 1 gal. of water.)
× 148.2 (Total head.)
÷ 33,000 (33,000 lbs. elevated 1 ft. in 1 minute equals one horsepower.)

$$100 \text{ gpm} \times 8.33 \times 148.2 = 3.74 \text{ theoretical horse power.}$$

$$\frac{33{,}000}{3.74 \div 60 \text{ (efficiency of pump)}} = 6.2 \text{ actual H. P.}$$

And finally, when you desire to use a pump on a new job proceed along the following lines, it will pay you every time.

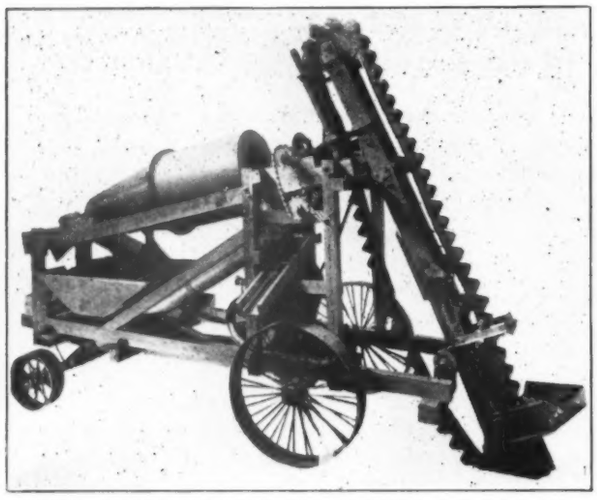
1. Assure the flow of water you want at delivery end of pipe.
2. Consult friction table and pick out the size of pipe which, for your total head, is about right.
3. Add your vertical lift from water to delivery level to the friction head for the size of pipe picked out.
4. If the total head, vertical lift plus friction seems excessive, go to the next size larger pipe.

A NEW PORTABLE SAND AND GRAVEL WASHER

Development of a portable sand and gravel washer, that meets the needs of contracts for light road work, is announced by the Link-Belt Company.

The new machine is not intended to replace permanent plants, but satisfies a demand for a small device which can be moved from bank to bank on road work and contracts where permanent plants are not readily available, and the gravel must be taken from small deposits.

The portable washer consists of an elevator, preliminary scrubber, screen and sand dewatering device, all mounted on heavy wheels with broad tires. The elevator is equipped with heavy steel buckets mounted on



VIEW OF NEW LINK BELT PORTABLE SAND AND GRAVEL WASHER.

single-strand chain. The elevator frame is constructed so that it can be folded up when the machine is to be moved. A small hand winch is provided to handle the elevator when it is to be folded or unfolded.

Mounted on the same shaft as the screen, and divided into compartments, is the Dull type of patented scrubber, which has lifting vanes or paddles on the inner circumference of the shell. These are so arranged that the material is thoroughly agitated and washed before it enters the screen. The screen itself is arranged to divide the material into one grade of sand, one grade of gravel, and remove the oversize.

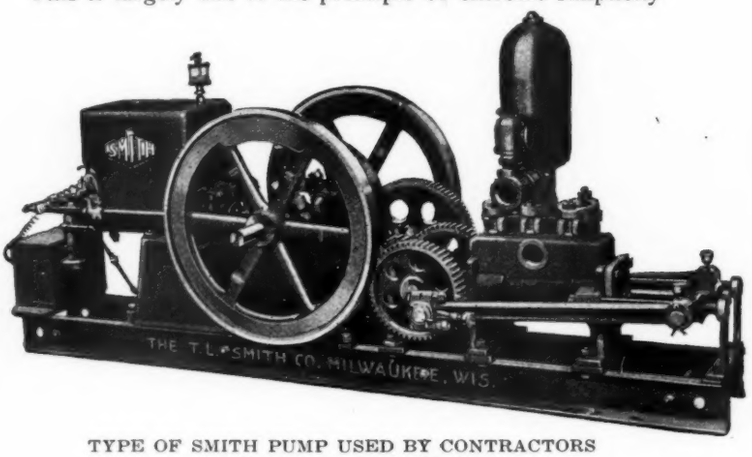
After passing through the screen, the sand and water are deposited into a settling tank, and the sand is dewatered by means of a heavy screw conveyor.

A gasoline engine mounted on the same frame supplies the power for the plant. The machine has a normal capacity of about 10 cu. yds. of pit-run material per hour.

BOOK ON PUMPING FOR CONTRACTORS AND ROAD BUILDERS

Pump users will find the pamphlet, "Never Failing Water," an interesting and instructive piece of literature in which the subject of pumps is treated in an exhaustive manner. Contractors and road builders will find it interesting because it contains pump statistics on uses in connection with paving machinery. It shows by example how to figure the size of a pump necessary to supply a certain quantity of water from any specified distance. It shows the friction loss developed by the passage of water through pipes of various sizes. It has a set of statistics showing the amount of friction caused by pipe fittings such as elbows, bends, valves, etc. Handy charts show at a glance the quality of water contained in rectangular or circular tanks of various dimensions. In addition it gives some valuable operating hints which will enable the user to get more efficiency out of his pumping outfit.

The book tells, too, about the complete line of Smith pumps, which includes force, diaphragm and centrifugal outfits of various sizes. Smith pumps have made a good reputation by their record of consistent performance. This is largely due to the principle of extreme simplicity



TYPE OF SMITH PUMP USED BY CONTRACTORS AND ROAD BUILDERS.

on which they are constructed. Fewer working parts are used and the design of the pump is such that any part can be removed without dismantling other parts.

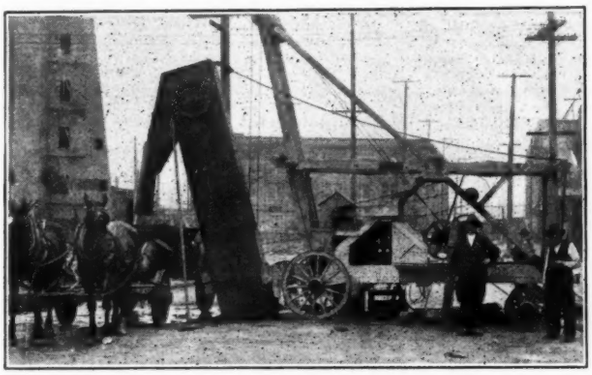
The Smith high pressure force pump is the only double-acting force pump with a double train of gears which has the jack bearings cast integral with the pump. This construction insures perfect and permanent alignment of the shafts and cross head pinions, a very important feature

and one which contributes greatly to the long life of Smith pumps. The book, "Never Failing Water," will be gladly sent free to interested parties. Write the T. L. Smith Company, 472 Old Colony Building, Chicago, Ill.

SAN FRANCISCO SEWER DEPARTMENT DESIGNS BUCKET ELEVATOR FOR CLEANING SEDIMENTATION CHAMBER

A bucket elevator was recently constructed under the supervision of Mr. M. M. O'Shaughnessy, City Engineer, San Francisco, Calif., primarily for the purpose of cleaning out a sedimentation chamber. The machine is illustrated herewith and Mr. W. H. Ohmen, Assistant Engineer, writes as follows of its successful use:

The sedimentation chamber for which this excavator was primarily designed is 10 ft. 6 ins. by 12 ft. 6 ins. and is approximately 1,400 ft. long. This is part of the main trunk sewer which is a combined storm and sanitary system. During the storm periods the sediment accumulates through this entire chamber to the height of the center



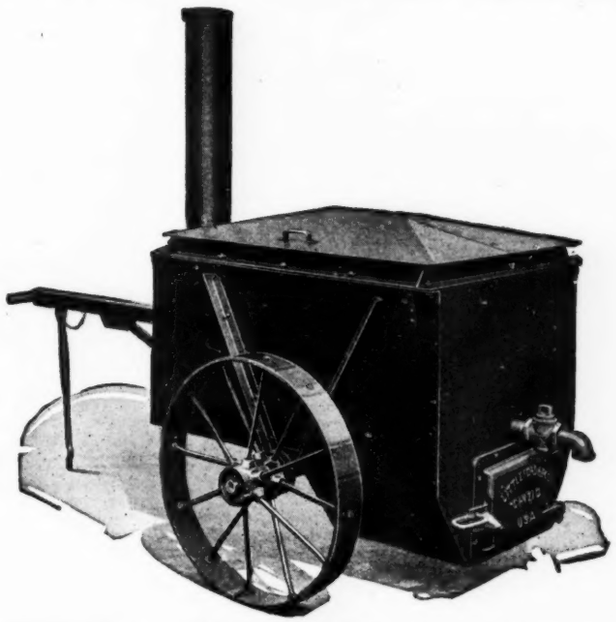
VIEW OF BUCKET ELEVATOR AS BUILT AND SUCCESSFULLY OPERATED BY CITY ENGINEERING DEPARTMENT OF SAN FRANCISCO FOR CLEANING OUT A LARGE SEWER SEDIMENTATION CHAMBER.

partition, 4 ft. high. After the rainy periods we drop the bucket excavator down one side of this sedimentation chamber and divert the flow to the other side by means of a dam at the inlet.

This device has proved very satisfactory. Under the old system of handling by bucket and windlass an average of about 4 yds. per day was all that could be obtained, but with the excavator in service we are getting out at least 28 yds per day, and when supplemented by longitudinal conveyor, which we have in mind to place on the partition wall in the center of the sedimentation chamber, we will probably accomplish twice as much work with it. This outfit cost approximately $2,300 and was designed to adapt itself to an old truck which belonged to the department. The elevator is designed to be supported from the cables at the center of gravity so that when raised it is easily tipped over and placed in a horizontal position on top of the truck for conveying through the street.

LITTLEFORD

TAR AND ASPHALT HEATERS



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CONTRACTS AWARDED

ROADS AND STREETS

Ala., Bessemer—J. F. Morgan & Co., awarded contract for paving 22 blocks, asphaltic concrete, at $269,566; Long & Hagerty, contr. to pave alleys with brick, at $22,500.

Ala., Birmingham—Road grading contracts involving 63½ miles of road awarded as follows: Pat Wallace, $49,235, 10 mi. betw. Warrier and Rebins cross-roads; $23,560, 3 mi. betw. Palos and Praco; $41,560, 5 mi. grading betw. Warrior and Coaldale, $10,560, 2 mi. Sadler's Gap; J. A. Dabbs, $72,175, 8 mi. betw. Oak Grove & Adger; A. F. Bearden, $80,154, 8 mi. Rocky Ridge rd.; $27,875, 2½ mi. betw. Irondale and Pole Cat Gap; Acton & Self, $27,905, 5 mi. rd. betw. Trussville and Acmar; Kershaw Constr. Co., $31,190; 5 mi. rd. betw. Clay and Trussville; J. B. Rylant, $14,700, 3 mi. Mt. Pinson to Center Point Rd.; John & Ira Parson, $14,020; 3 mi. rd. betw. Pleasant Hill & Morgan.

Ariz., Phoenix—Twohy Bros., Spokane, awarded contract by Commrs. of Maricopa County for following, at their bid of $4,000,000: grading & paving with one-course Portland cement 170 miles of highway to width of 16 ft. This is total of 1,500,000 sq. yds. 6-in. concrete paving.

Ark., Rison—Jno A. Perdue, Pine Bluff, awarded contract to constr. 10 miles Calmer Road, at $104,000.

Cal., Napa—Randome-Randall Co., 28th and Poplar Sts., Oakland, awarded contr. for constructing 11.6 miles conc. road betw. Rutherford and Calistoga, Napa Co., at $171,000.

Cal., Sacramento—Geo. S. Benson & Sons, Stimson Bldg., Los Angeles, awarded contract for paving with concrete 10.7 miles of state highway in Yolo Co.—Woodland to Zamora—at $140,889.

Cal., Sacramento—Riley & Peterson, (W. F. Riley, 2245 National Ave., San Diego; H. H. Peterson, Calexico), awarded contr. for paving with conc. 11.3 miles of state hwy. in San Diego Co. betw. Flinn Springs to Ogden Ranch, at $177,529.

Cal., San Diego—Kier Constr. Co., San Diego, awarded contract for paving Lemon Grove Rd., No. 4, at $160,723.

Cal., Woodland—Clark & Henery Constr. Co. Ochsner Bldg., Sacramento, awarded contr. for paving first unit of Yolo Co, Hwy. system, 10.7 miles, at $226,441.

Conn., Hartford—Immick Co. State St. Meriden, awarded contract by State Hwy. Comn., for bldg. 9,000 ft. hwy. 3-in. bitum. macadam on broken stone base, Wallingford Twp., at about $70,000; 5,100 ft. Howe Ave. asph. on 6-in. conc. base, Shelton Twp. to Conn. Hassan Paving Co., 920 Chapel St., New Haven, at $80,000.

Del., Dover—Keystone State Constr. Co., Commercial Trust Bldg., Phila., awarded contract for bldg. 4.14 miles Townsend-Pine Tree-Odessa Rd., 16 ft. wide, at $240,072.

Ida., Rexburg—Gibbons & Reed, Salt Lake, awarded contract for 12 blks. street paving, ten blks. of sidewalks and 12 blks. of gutters, at approx. $170,000.

Kans., El Dorado—Meredith Co., El Dorado, awarded contract to pave sts. in Florence, at about $100,000.

La., Covington—Lawrence, Nixon & Phillips, Jackson, Miss. and R. S. Daniels, awarded contract to surface 33.5 miles of road with gravel, at $218,000. Mr. Daniels located in Covington, La.

Md., Chestertown—Kent Constr. Co. Felton, Del., awarded contract by Kent Co., Commrs. to construct roads, at $340,000.

Mass., Boston—Thomas & Murphy Co., Keene, N. H., awarded contr. to build 56,400 ft. state rd. 22 ft. wide, Eastham & Wellfleet Twps., involving 12,900 tons bitum. conc. 56,000 gal. bitum. macadam, 5,200 cu. yds. earth excav. at $166,047.

Mich., Grosse Point (Detroit, P. O.)—G. R. Cooke, Penobscot Bldg., Detroit, awarded contract for grading, shaping and paving 1 mi. St. Clair Ave., involving 18,000 sq. yds. asphaltic concrete on 6-in. concrete fdn., at about $119,000.

Mich., Lansing—Following contracts let for Mich. State trunk line; Oosting & Hofsteen, Holland, rd. in Ottawa Co., Holland-Olive Twp., at $4,390, with F-conc., at $160,579; Thos. E. Currie, Detroit, Macomb Co. Lenox, 4.331 mi. F-conc., at $174,958; J. Orr Standish, rd. in Ogemaw Logan Twp., 3.052 mi. B-gravel, at $40,126; also rd. in Logan-Churchill Twp., B-gravel, 5.470 at $84,007; Jno Meshler, Freeport, rd., in Ionia Co., Campbell Twp., 3.967 mi. of B-gravel at $41,474; Schneider O'Harrow, Lowell, Ionia Co., Lowell-Boston Twp., grading, draining, structures, at $26,230; Hull & Gasner, rd. St. Clair Co., Port Huron, St. Clair, Columbus & Casco Twp. for grading, draining, structs. $140,753.

Mich., Mt. Clemens—Detroit Asphalt Paving Co., 20 McGraw Bldg., awarded contract for grading, draining and surfacing 1.964 miles of Rd., 46, near Richmond, 20-40 ft. wide, involving 26,000 sq. yds. asph. conc. on 7-in. concrete base. at $122,780.

Mo., Jefferson City—Pope Constr. Co. awarded contract to construct 12½ miles bitum. macadam hard-surfaced road in Boonville Special Rd. Dist. at $200,000.

Mont., Helena—Louis Johnson, City awarded contract State Hwy. Comn. for bldg. Helena-to-E. Helena and Jefferson Co. line hwy.; also paving of main street of E. Helena, at $88,000, not including the cement which Comn. will purchase for county and city governments; White, Brown & Leahy, awarded contract for Great Falls-Belt project, at $220,000.

Mont., Helena—B. P. Melchert, Lewistown, awarded contract for surfacing F. A. proj. No. 27, half of the Grand Range-Roundup proj. at $105,365.

Mont., Livingston—C. T. Heaton, Constr. Co. local, awarded contr., for 6-in. plain concrete paving, at $414,000.

Neb., Columbus—Allied Contractors, Inc. 4616 Harney St. Omaha, Neb., awarded contract for 2 miles of F. A. paving. Est. cost $85,000.

N. J., Elizabeth—Standard Bitulithic Co. awarded contr. for repaving Jersey St., at $100,099, Baltic St., at $32,195; South St., at $25,339, John E. Donovan, Summer St., at $42,859 and repaving Maple Ave., from Summer St., to Bayway, at $32,631.

N. J., Freehold—C. G. Julian Engrg. & Contg. Co., 20 Nassau St., New York City, awarded contract for bldg. 1.8 miles Eatontown Blvd., Eatontown to Long Branch, 22 ft. wide, at $105,301.

N. C., Salisbury—R. M. Hudson Co., awarded contract for paving 2.2 miles of streets, 25-27 ft. wide, bitulithic on 5-in. bitum. conc. base, at about $150,000.

O., Jefferson—C. G. Fuller, 139 Mill St., Conneaut, awarded contract for grading and paving 5.8 miles Rime-Morgan Rd., 10 ft. wide, involving 22,539 cu. yds. earth and 60 cu. yds. rock excav., etc., etc. at $169,774.

Okla., Comanche—Municipal Excavator Co., 200 E. Main St., Okla., awarded contr. for paving 15 blocks, at $136,450.

Okla., Mangum—Municipal Excavator Co., Okla. City, Okla., awarded contract for street impvt. dist. No. 1, at $209,890; asph. conc. on conc. base.

Okla., Sallisaw—M. A. Swatek & Co., Okla. City, Okla., awarded cont. for paving in Districts Nos. 2 and 3 in Okemah, Okla., at $120,000.

Pa., Harrisburg—Good Roads Constr. Co. Erie, awarded contr. to construct section of Route 87—approx. 7,300 ft. long and 18 ft. wide— Harbor Creek Twp. Erie Co., at $83,839; one-course rein. conc.; Mangan & Risser, Lebanon, Pa., awarded contract to build sect. of Route 162, Schuylkill Co., at $558,754; abt. 38,315 ft.

Pa., Harrisburg—Following contracts let by Hwy. Comn.: Huntingdon Co., Millcreek Boro., 4,243 ft. to Standard Contg. Co., Altoona, $46,206, Lawrence Co., Pulaski Twp., 28,644 ft., Woods & Golder, New Castle, at $320,331; Fayette Co. Bulskin and Upper Tyrone Twp., to J. I. Dick,, Scottdale, at $108,408; Mercer Co., Jefferson, Delaware and Hempfield Twps., 48,465 ft. Donald McNeil Co., Pittsburg, at $385,230; Cambria Co. Allegheny & Cambria Twps. and Ebensburg Boro., 24,431 ft. Polo., Assara, Cresson, at $364,171; Erie Co., Waterford & Summit Twps., 42,900 ft. Carey, Campbell & Co., N. Y. City, at $520,755; Ambler Davis Co., contr. for bldg. 25,911 ft. State hwy. in Horsham & Moreland Twps. Montgomery Co., at $281,406; Wm. C. Evans,

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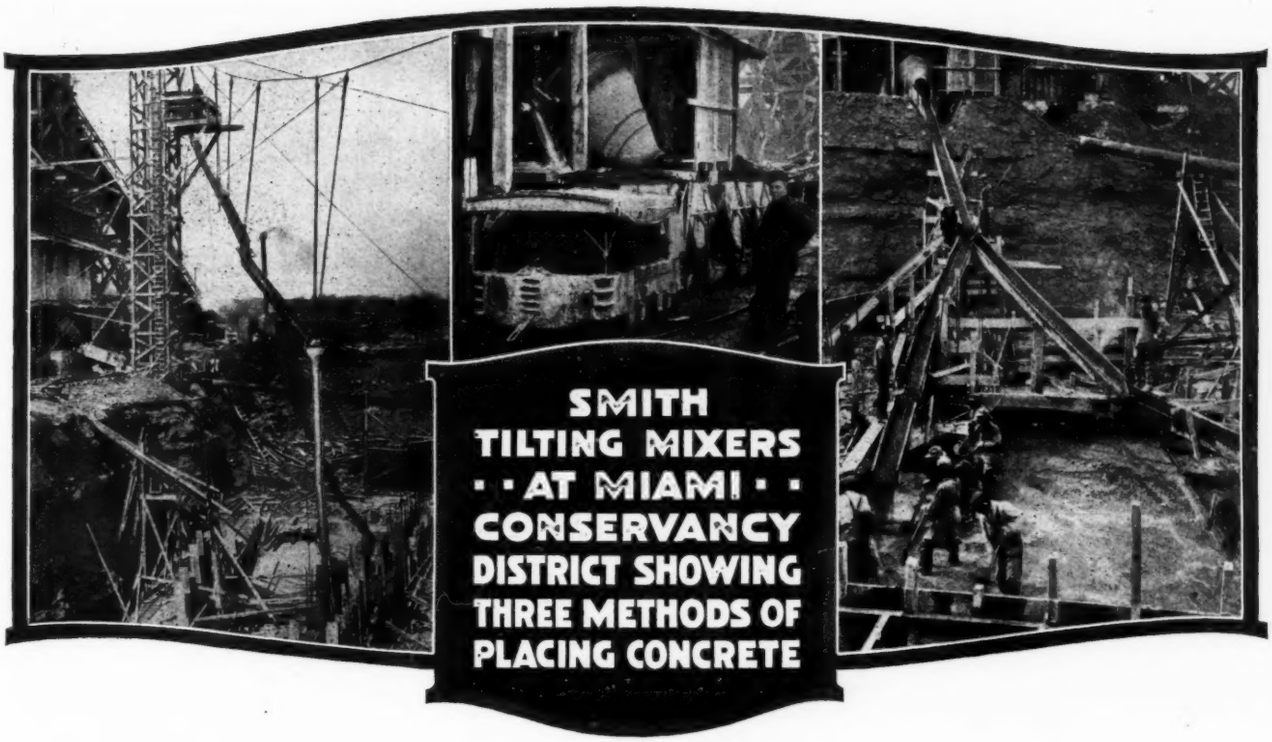

THE methods employed in the Miami Conservancy projects have been frequently commended in various details and as a whole, for their exceptional efficiency. It is generally conceded that the work on the five enormous dams which will eliminate the dangers of Ohio Valley floods, was accomplished in a most scientific manner with a minimum of time, labor and money.

It is significant that Smith Tilting Mixers were used exclusively on this work. The concrete poured will total over 200,000 cubic yards.

The peculiarly efficient adaptability of the Tilting Smith for this work is suggested by the above illustrations. No other mixer could have handled the work as thoroughly and as speedily.

Do you know that the Tilting Smith (one yard size) will gain about 40 batches per day over the fastest non-tilting mixer? Do you realize that means about $100.00 per day increased production—with no increase in fixed charges or overhead? And do you know that the Smith has records of service as long as 18 years, whereas the average life of a mixer is 3 to 4 years?

Find out about Smith Equipment—it represents Value that Endures. Write for catalogs.

Smith Tilting Mixers
Smith Simplex Paving Mixers
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Smith Excavator and Loader
Construction Equipment

THE T. L. SMITH COMPANY

474 Old Colony Bldg. **CHICAGO, ILL.**

STANDARDIZE ON SMITH EQUIPMENT

Ambler, contr. for 7,471 ft. rd. in Swarthmore and vicinity, at $83,301.

Pa., Phila.—State Highway Department at Harrisburg awarded more than 36 miles of highway contracts as follows: Schuylkill Co., 39,500 ft. Rush, Dyer & Mahanoy Twps. Route 290, Cease, Picton & Harrison, Wilkesbarre, $850,383; Adams, 62,042 ft. Latimore, Huntingdon, Tyrone and Strahan Twps. & York Springs Boro, Route 123, Geo. Kerdinger, Bethlehem, $511,606; Chester & Delaware, 19,417 ft. Westown, Willistown and Edgemont Twps. Route 133, Dunleavy Bros. Coatesville, $212,849; North Cumberland, 20,545 ft. Point Twp. & North Cumberland Boro., Route 2, Mason & Hanger Co., Paxinos, $230,737; Bradford, 43,573 ft. Canton & Alba Boros. Phila., Pa.—Barber Asphalt Co. awarded contract for grading and paving Passyunk Ave.—28th street to Schuyler Ave.—at $103,300.

S. D., Sioux City—Beebe Paving Co., Omaha, awarded contract for abt. 3 miles of paving at $300,000—7-in. concrete.

Tex., Beeville—Wright & Sanders, San Antonio, awarded contract to hard surface 22 miles state highway No. 9, at $426,000; Bee County.

Tex., Coleman—Arthur Smith, Blanket, awarded contr. by Coleman Co., Commrs. Precinct No. 2, to construct 18.66 miles gravel road; concrete bridges and culverts, at $100,000.

Tex., Emory—Allhands & Davis, Dallas, awarded contract for bldg., 23.3 miles hwy. No. 42, Haines County, at $126,000; county to furnish material for $119,000—total cost $245,000.

Tex., Fredericksburg—M. M. Craven, Houston, Tex., awarded contract to grade and surface with gravel and crushed rock 17 miles Hwy. No. 9; $172,902.

Tex., Lufkin—Haden & Austin, Houston, awarded contract to construct 4 mi. bitum. pavement, macadam base, curbs and gutters, at $150,000 to $200,000.

Tex., Marshall—Smith Bros. & Hanly Constr. Co., Meridian, Miss. awarded contr. for constr. of 39.45 mi. Hwy. No. 11, at $380,000 brdgs. & culverts included.

Tex., Orange—Houston Constr. Co., Houston, Tex., awarded contract to construct 10.26 miles conc. road; steel bridges over Cow Bayou and Cole's Creek; culverts, etc., $451,783.

Wash., Seattle—Robt. A. Sloane, Seattle, awarded contract for Latah-Fairfield-Waverly Hwy., by Co. Commrs., at about $14,300 per mile for 13½ miles, or total of $190,476.

Wash., Tacoma—D. A. Williams, Tacoma awarded contract for grading, draining and paving Midland-Summit Hwys. for 6.47 mi. at $219,000.

W. Va., Clarksburg—T. Pietro Co., Morgantown, awarded contract for paving and bldg. sewers in Ferry and Chestnut Sts., at $60,000; to F. L. Grant, Inc., Clarksburg, for similar work in Pike, Elk, Main and 6th Sts., at $100,000.

Wis., Superior—Peterson & Nelson, 1201 13th St., Superior, awarded contract for paving Grand Ave., from city limits to Spalding Ave., with concrete, 18 ft. wide, about 6 miles, at $264,000.

SEWERAGE AND SEWAGE TREATMENT

Cal., Bishop—Wm. D. Walsh, 1235 Dewey Ave., Los Angeles, contr. for vitr. pipe sewer system for Bishop, at $31,365. Work involves 6-in., 12-in. and 14-in. pipe, 45 manholes and 8 flushtanks.

Cal., Calipatria—H. H. Peterson, Calexico, awarded contr. for constr. of vitr. pipe sewer system here, at $39,450.

Cal., Long Beach—United Dredging Co., Central Bldg., Los Angeles, awarded contr. for laying sewer pipe and bldg. manholes at the silt diversion channel in Long Beach, at $5,999.

Cal., San Bernardino—F. W. Seccombe, awarded contr. for constructing vitr. pipe sewer in 7th, A and 4th Sts., at $5,011.

Colo., La Junta—Reed & Wheelock, Clay Center, Kans. awarded contract for bldg. new storm sewerage system, Dist. No. 1, at $62,481.

Conn., Bridgeport—Pierce Mfg. Co., 785 Housatonia Ave., awarded contract for laying 15 miles pipe sewer at about $259,000.

D. C., Washington—Adam McCanlish, 807 Mt. Vernon Pl. awarded contr. to construct 365 lin. ft. 2-ft., 6-in. by 3-ft. brick and concrete sewers, at $5,400.

Ida., Rexburg—Chas. Thompson, Utah, awarded contract for sewer work at cost of $52,000.

Ind., Lafayette—J. F. Hipskind, 233 Colonial St., Richmond, awarded contract for bldg. sewerage system, at about $70,000.

Ind., South Bend—Jo. A. Luther, awarded contr. for pipe sewer on Ewing Ave.—High St. to Erkskine Blvd.; pipe sewer on Jefferson Blvd.—Walnut St. to Chestnut St. to Bruno DePaepe; pipe sewer on Wakewa Ave.,—Iroquois St. to Lafayette Blvd.—to Hoban and Roach, at $7,880; trunk sewer on Michigan St.—Fairmont to Donmoyer Sts.—to Staples and Ackerman, at $50,615.

Ia., Alba—J. W. Turner Impvt. Co., 309 Youngerman Bldg., Des Moines, awarded contract for bldg. san. sewers in various streets; sewage disposal plant, to A. Phelps & Sons, Knoxville, at $36,828.

Ia., Burt—R. L. Cox, Webster City, awarded contr. for san. sewer system in city, at $35,576; H. A. Teget, Webster City, contr. for dispcsal plant, at $23,640.

Ia., Cushing—Ward & Weighton, award. contr. for sewage disp. plant, at $10,995 (Contractor located 516 Davidson Bldg. Sioux City); Sieg Constr. Co., Waterloo, contr. for bldg. main and lateral sewers in various streets, at $18,098.

Kans., Hutchinson—Burt & Tripp, awarded contract for construction of lateral sewers 76, 89 and 91, at $18,641.

Kans., Protection—Amerman & Snyder, Wichita, awarded contract for laying sewers in various streets and bldg. sewage disp. plant at $48,500.

Kans., Sedgwick—Foster & Skaer, 600 E. Douglass Ave., Witchita, awarded contract by city for improving sewers in various streets, at $40,048.

Ky., Lexington—Southern Bldg. & Supply Co., awarded contracts for Virginia Ave., and Drake St., sewers, at $3,240 and $2,634, respectively; C. E. McGregor, contr. for Winnie Street sewer at $2,456.

Mass., Boston—Wm. Barrett & Co., awarded contract for bldg., catch-basins, manholes and minor drains in Boston, at $16,305; also contr. for sewerage works in Unity Court—Unity St. 154 ft. westerly and northerly, at $2,884.

Mass., Reading—A. Cefalo, 316 Belgrade Ave., Roslindale, awarded contr. for laying 10,000 ft. vitr. pipe sewers in various streets, at about $30,000.

Mich., Detroit—J. A. Mercer, Detroit, awarded contr. for bldg. sewer in Sect. 1, Gratiot, Ave., at $485,000.

Minn., Duluth—Johnson and Kortonen, awarded contr. for laying sanitary sewer in 99th Ave., West, at $2,670.

Minn., Lake Benton—Pastoret Constr. Co., 511 Lyceum Bldg., Duluth, awarded contract for sewer system and water main extens., at $104,940.

Mo., St. Louis—Meyers Constr. Co., Merchants Laclede Bldg., awarded contract for bldg. sewerage system in Pub. Outlet Glaise Creek Sewer Dist. 17, involving 71 ft. 6-36 in. vitr. pipe and 1,375 ft. 48 63 in. segmental blk. pipe, at $23,777.

Neb., Long Pine—Katz Constr. Co., 1817 Douglas St., awarded contract for sewers, at $60,000.

N. J., Elizabeth—Villa Bros., Westfield, N. J., awarded contr. for new rein. conc. pipe drain and necessary appurts. on Stuyvesant Ave., at $5 706.

N. J., Hoboken—W. T. S. Crichfield, 54 Fifth St., awarded contract for bldg. sewers in 7th and 15th streets, at $327,752 and $433,622, respectively.

N. J., Pleasantville—City let contracts for bldg. sewage screening plant and pumping station to Seaman, Letzkus & Smith, at $42,914; force mains and mechanical equipt., to Simpton & Brown Co., 90 West St., N. Y. City, at $21,890 and $32 261, respectively.

N. Y., Brooklyn—P. Tomasetti Co., Inc., 1133 60th St., awarded contr. for furnishing labor and material for bldg. sewer in 65th and 12th streets, at $10 493 and $1 545, respectively; President St., to J. O'Leary, 929 Peace St., Pelham Manor, $5 202.

N. D., McVille—Gedney & Murphy, Fargo, awarded contract to build sewer system, at $25 877.

O., Alliance—R. M. Scranton, awarded contr. for construction of san. sewers on Ohio, Milton and Harrison streets, at $5 997.

O., Cleveland Heights (Warrensville P. O.)—N. Iafornarom, 3218 Murray Hill Rd., awarded contract by village for bldg. sewers and water mains in Cumberland Ave.—Lee to Mayfield Rds.—at $35,412.

O., Cleveland Heights (Warrensville P. O.)—Hadded Mall Co., Schofield Bldg., Cleveland, awarded contract by Cedar Heights Land Co., for bldg. sewers and water mains in Bainbridge, Revere and Stanton Roads, Berkeley and Blanche Aves., at $189,946.

O., Dayton—Chas. F. Smith & Son, Dayton, awarded contract for constr. of Mt. Auburn sanitary sewer district, at $141,000.

O., Dayton—Gessner Co., Toledo, awarded contract for bldg. 30,000 ft. 6-24 in. vitr. pipe san. and storm sewers in Mt. Auburn Sewer Dist. No. 2, at $137,608.

Okla., Okemah—N. S. Sherman Mach. & Iron Wks., Okla. City, awarded contract for sewers in Lat. Sewer Dist. No. 1, at $181,700.

S. D., Clark—Wm. Danforth, St. Paul, awarded contract for construct. of sewer system here, at $66,000.

S. D., Kimball—Kircher Bros., Olivia, Minn., awarded contract for construction of sewer system, at $82,000.

Tex., San Antonio—Following contracts let by City Commission: Sanitary sewers in West End Dist., $38,078; McKenzie Constr. Co., storm sewers in Elmira St., lay 24-in. mains, $12,211; Elder Constr. Co.; storm sewer in Rivas St., lay 30-in. main, $6,572. J. L. Black, Contr.

Wis., Milwaukee—G. E. Zimmerman, 3102 McKinley Blvd., awarded contract for bldg. sewers in Second Ave. and Scott St., involving 5,635 ft. 60-in. conc. sewer in tunnel, stand. and drop manholes, etc., at $263,934.

WATER SUPPLY AND PURIFICATION

Ala., River View—Hardaway Constr. Co., Columbus, Ga., awarded contr. by Riverdale Cotton Mills, to construct conc. dam in Chattahoochee River; 1,000 ft. long, 12 or 14 ft. high; replace wooden structures; $100,000.

Can., Scarboro Twp., Ont.—Central Foundation Co., Norwich Union Bldg., Toronto, awarded contract for laying about 10 miles of water mains; Kerr Engine Co. contr. for valves; Drummond, McCall Co. contr. for fire hydrants—total est. cost of contracts $180,000.

Can., Montreal, Que.—Fraser & Chalmers, Ltd., Montreal, awarded contr. by Adminis. Comn. for electric pump, 30,000,000 gals. daily, at $50,250; E. Laurie Co., Montreal, contr. for electric pump having same cpy., at $42,200; Canadian General Electric Co., contr. for manufacture, delivery and installation of transformers, etc., at $48,840. It is intention of authorities to install more electric pumps as plan for impvt. of aqueduct sys., adopted by City Commrs., requires initial installation of five 30-million gal. elec. pumps, with accommodation in bldg. of 3 additional units. Bldg. is new motor-driven pumping plant which city is to construct at est. cost of $850,000.

Can., Regina, Sask.—Walsh & Charles, Winnipeg, awarded contract by Council for furnishing water meters, at $5,824.34.

Fla., Winter Garden—Ladd & Giles, Winter Garden, awarded contract to build water works; City has 80x25 ft. power house; contracts were awarded for electrical machinery, pumping equipt. engines, 75,000-gal. tank, etc., at $127,000.

Ida., Moscow—Pittsburgh-Des Moines Steel Co., Curry Bldg., Pittsburgh, awarded contract for bldg. 80-ft. steel tower, 300,000-gals. capy., at $31,556.

Mass., Boston—Jas. Barletta awarded contract for laying and relaying water pipes in Wood Ave., Hyde Park, Athol St., Raymond, Riverdale and Waverly Sts., Brighton, at $5,407; C. & R. Construction Co. contract for laying and relaying water pipes in Blackstone, Chambers, Friend, Richmond, Berkeley and East streets, city proper, at $7,412.

Mich., Lansing—Ellington-Miller Co., 417 S. Dearborn St., Chicago, awarded contract for bldg. concrete reservoir, 250,000 gal. capy.; also installing air-lift on 19 wells, and electric drive air compressor, at about $75,000.

Minn., Virginia—Heine Safety Boiler Co., St. Louis, Mo., awarded contr. for two 775 h. p. boilers, at $33,070.

New York City—Henry E. Fox Constr. Co. 81 E. 125th St. N. Y. City, awarded contr. for constructing masonry guide walls and miscellaneous work, at Ashokan Spillway, Marbletown, Ulster Co., N. Y., at $85,575.

N. C., Asheville—R. C. Stevens, awarded contract to build intake and settling basins at Bee Tree, at $19,224.

O., Canton—Burke Constr. Co., Canton, awarded contract for bldg. rein. conc. reservoir, 16 ft. deep, 3,000,000-gal. capy. at about $30,000, by Canton Sheet Steel Company.

Okla., Pawhuska—Hamilton Bros. Pawhuska, awarded contract for bldg. dam with

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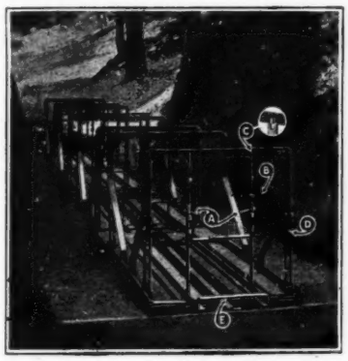

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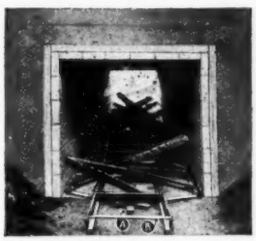

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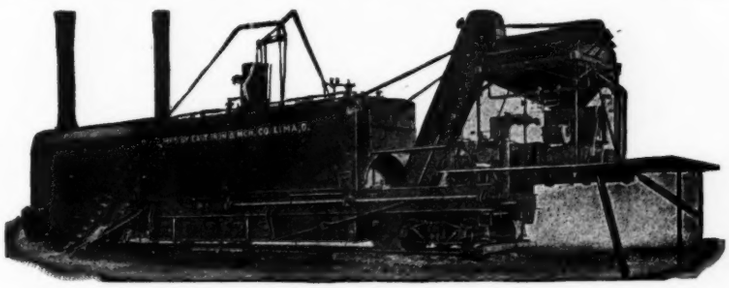

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intake system, 35 ft. high and 450 ft. long on shale fdn., at about $75,000.

Pa., Wharton—W. G. Fritz, Essex Bldg., Newark, N. J., awarded contract for laying water mains in various streets, at about $400,000.

Utah., Murray—Pacific Pipe & Tank Co. San Francisco, awarded contr. for redwood pipe for water system, at $55,754; D. C. Dunbar, Salt Lake City, hydrants & valves, at $5,354; Hooper Drainage System, Ogden, for installing distributing system at $18,017; Enoch Smith, Salt Lake, contr. for constructing reservoir, at $6,911; D. B. Burton, Holliday, contr. for erection of sand trap, at $920; Thos. De La Mar, Salt Lake, contr. for concrete pipe line, at $24,204.

PROSPECTIVE WORK

ROADS AND STREETS.

Ala., Mobile—Property owners in favor of paving So. Pascagoula St. from present paved sect. at Jackson street to the beach —about 2 miles.

Ariz., Phoenix—State Engr. Thos. Maddock has secured fed. aid for construction of Superior-to-Miami Hwy. covering heavy rock work. Est. cost of road $540,000 and application for fed. aid has been made for entire project.

Ark., Little Rock—Ords. passed for curbing and guttering dists. No. 284 and Paving Dist. 285. Ords. creating street and curbing dists. in Hillcrest, also passed. District takes in about 50 blocks in ward.

Ark., Russellville—Surveys started in Road Impvt. Dist. No. 2, Pope Co. which will construct 45 miles of macadam road; $700,000 bonds. J. O. Hill, Secy. W. W. Mitchell, with Ford & MacCrea, Little Rock, appointed engineer for 43 miles of roads in Pope Co.

Ark., Hawes—Garland Co. Rd. Impvt. Dist. No. 6 has selected Southwestern Engrg. Co. Texarkana, Tex., as Engrs. Work will consist of 40 miles gravel road. $450,000 bonds voted but not sold. Frank Redford, Secy.

Ark., Lonoke—If plans of local business men mature Town will soon have paved streets and a sewer system. Comm. formed to formulate plans for the impvts. headed by Mayor Jacob Gates.

Cal., Los Angeles—City Council today approved assessment map submitted by City Engr. Jno A. Griffin for paving Hoover St., betw. Slauson and Manchester Aves. Est. cost of impvt. approx. $221,000. Paving will consist of 5-in. concrete base and 2-in. asph. wearing surface.

Cal., Visalia—In about a month the Supervisors will call for bids for 6½ miles concrete paving on Orosi-Orange Cove Rd., in northern sect. of county; also a little later, for 9.25 miles Elderwood-Yetta Rd., abt. 4 miles distant from 1st named job; Elderwood work to be conc. and macadam paving.

Colo., Colo. Springs—Council adopts paving plan for four streets: Colorado Ave. $432,874; Cascade Ave., $280,753; S. Nevada Ave., $197,183 and East Platte Ave., $189,188—total cost $1,100,000.

Colo., Denver—Colo. State Hwy. Comn. plans to improve following roads: graded mtn. road in Grand Canyon at $97,110; gravel rd. 3½ from Wray to Schram, $29,767; 10-mi. gravel surf. rd. from Las Animas to Lamar, at $89,522; 2.7 mi. conc. paved rd. from Littleton so. toward Colo. Springs, at $108,790. Comn. will also appropriate $50,000 for completion of Big Thompson canon road in Larimer Co. $311,000 worth work planned for the impvts. on Denver-to-Morrison Turkey Creek, Canon and Arvado Roads.

Ida., Caldwell—Petitions presented to Council for about 33 blks. of paving and abt. 1 mile of walks. F. L. Lockwood, City Engr. Specfs. will call for bitulithic on bitum. base.

Ida., Boise—State Hwy. Dept. plans to rock and gravel surface 40 mi. of roads; 12 to 20 ft. wide. Will do most of the work by day labor. Abt. $300,000.

Ida., Sandpoint—City Council has retained Dennis Woods, Spokane, for engineering prelim. to Oak street paving district. He will prepare all plans and specfs. Rough est. of cost of impvt. dist. $100,000.

Ill., Chicago—Spring street paving to cost $1,260,000 recommended for passage by City Council at meeting of Sys. & Alleys Comm. Streets and cost for each: Leamington Ave. —Belden to Grand—$430,000; Mich. Ave.—Garfield Blvd. to 63rd, $146,500; Normal Ave. —111 to 115th, $138,500; Troy—Archer to 47th, $146,000; Pensacola Ave.—Lockwood to Central, $135,000; Waveland Ave.—Elston to Central Park, $114,500; Trumbull Ave.—Foster to Balmoral, $148,000. Amounts stated are those named for contracts.

Ill., Joliet—Ord. passed by Council authorizing paving Miller Ave., Akin Ave., Henry St. Hobbs Ave., Baker St., and Washington St. Est. cost $56,000.

Ill., Mendota—Ord. passed to pave with rein. conc. sections of Burlington St., 13th Ave. Wisconsin Ave. Michigan Ave., Indiana Ave., Meriden St., Springfield St., Chicago St., Illinois Ave., and Sixth St.

Ill., Moline—Ests. for extension of 13th St. paving from 5th Ave. to Ave. thence no. to Second, approved by Bd. Local Impvts. Plans also provide for paving Third Ave.—19th to 22nd Sts. These 9 blks. will be paved with asphaltic concrete. Est. cost $54,925.

Ill., Potomac—Vermillion and States streets are to be paved; surveys now being made. Paving in business dist. is to be from curb to curb and thru residence dist. 20 ft. wide. Main road north of here will also be paved to the A. Z. Vopeland corner.

Kans., Wellsville—Ord. passed by Council to grade, curb and pave Main Street from 4th to 8th Sts. Engr. C. A. Shockley instructed to prepare plans and specfs. for 3 types of paving—conc. asph. and bitum. macadam. Paving will probably be 75 ft. wide in business section and 36 ft. wide betw. 7th and 8th sts.

Ky., Ashland—Resolution adopted by Council that sections of following streets and streets be improved by paving with tarvia or bitum. paving, with curb and gutter, in accord. with stand. spefs. of City, etc.: All streets or parts of streets in South Ashland as follows: Park, Short, Ferguson, Hampton, Hackworth, Holt St., W. A. Manning, City Clk.

Md., Easton—Talbot County will expend $200,000 for impvt. of county roads. Austin C. Shure, Chestertown. Dist. Engr.

Mass., Danvers—City plans to expend $30,000 to pave various sts.; penetration method. J. B. Brown, Supt.

Mich., Adrian—Plans of County Rd. Commrs. for paving Bent Oak Ave., and N. Main St. beyond Seeley St. approved by City Comn. Both sts. will be paved with tar penetration macadam; 20 and 18 ft. wide.

Mich., Benton Harbor—City Council has adopted estimates prepared by City Engr., for re-surfacing asph. of the business section of town, using present base. The streets included under present proceedings are: Pipestone, East and W. Main, Park, Wall, Colfax, Water and Britain Ave.

Mich., Detroit—City soon to receive bids for shaping, grading and paving 2,200 ft. Thaddeus St., $36,850; Evans Ave.—Pershing St. to Gartner Aves., $20,330; Richardson St.—Mt. Elliott to Foster Aves., $17,430; Wilson Ave.—Pallister to Seward Aves. $15,400—all 26 ft. wide; sheet asph. on 6-in. conc. base, Berea on Medina curbst. C. W. Hubbell, City Engr.

Mich., Iron River—Village Engr. Laing instructed to make survey of sts. where paving will be installed. Work will begin almost immediately and will be submitted to Council at early meeting. Comn. will pave 20 ft. of Adams St., with conc. from western limits to Iron River-Crystal Falls road; remaining 12 ft. of 32 ft. road will be paved by property owners on street who will be required to make all water and sewers connections before June 6th. One-half mile of paving with integral curbs will be amt. of impvt. on Adams St. Work of paving 4th St. will begin within a few weeks.

Mich., Port Huron—City will soon ask bids on grading, shaping & paving with conc., conc. curbing, Gratiot Ave., $54,868; Court St., $36,266; Pine Grove Ave., $27,275; Stone St., $6,158; 22nd & Railroad Sts. $2,769; Griswold St., $2,117; Park St., $4,202; Alley Blk., 58, $184.; Glenwood Ave., $12,100; Mich. St., $4,716; Minnie St., $9,968; Jenkinson St., $2,703; Moak St., $3,620; Court St., $9,861; 4th St., $5,906; 4th St., $3,449.

Mich., Royal Oak—Preparations being made for additional paving. Petitions received from residents of Lafayette St.—Fourth to 1st for impvt. and Engr. is working on plans, while estimates are being considered for Washington Ave.—4th to 1st; Harrison St.—Main to Washington; Washington and Woodward Aves. from vicinity of Ten Mile Rd. and 5th St. from Washington to Main Sts.

Minn., St. Paul—Ord. for paving Maryland St. passed by City Council. Est. cost of the work $80,000. Part of the street will be paved with sheet asphalt.

Miss., Clarksdale—$500,000 bonds voted to improve streets, construct 2nd St. bridge, reservoir, etc., R. E. Stratton, Jr. Clk.

Miss., Columbus—Petitions to be presented to City Council for paving College street business sect. to Miss. State College for Women—abt. one mile.

Miss., Meridian—City has voted in favor of $290,000 bonds to pave 24th Ave., repair paved streets, construct perm. conc. brdgs. and erect an incinerator.

Mo., Jefferson City—City plans to resurface 160 blks., involving 300,000 sq. yds. surfacing.

Mo., St. Joseph—J. D. Mohler, Special Hwy. Engr. has been instructed by County Court to begin survey of Pike's Peak Hwy. from end of pavement at 102 River to east county line. Court also expects to start work soon on extension of Mitchell Ave., Rd., from end of pavement a mile east of city limits to 102 River.

Mont., Thompson Falls—Co. Commrs. have decided that $150,000 County and Fed. money will be expended on paving Dixon-Perma, Whitepine and Dog Lake projects.

N. J., Long Branch—City plans to pave various streets involving 130,000 sq. yds. bitum. E. E. Throckmartors, City Engr.

N. J., Vineland—City plans to pave various streets, involving 40,000 sq. yds. concrete or brick. Remington & Vosbury, 6th and Market Sts., Camden, Engrs.

N. M., Silver City—$700,000 may be expended for impvt. of county roads including Mogollen Fed. Aid. Hwy. and Santa Rita F. A. Proj. Bids to be called soon. Address Chrmn. of Rd. Comm. Grant Co., Chamber of Com.

N. Y., Auburn—City will receive bids in June for paving 20,000 sq. yds. various streets. All types pavement to be considered. M. F. Dullea, City Engr.

N. Y., Binghamton—45,000 sq. yds. of streets may be paved with asphlt., conc., brk., and wood blk. Abt. $40,000 available. W. E. Weller, City Engr.

N. Y., Corning—City contemplates paving 18,890 sq. yds. of streets; plain and Hillside brick and crushed stone. Abt. $86,000 available. W. O. Drake, City Engr.

N. Y., Fairport—City plans to pave 23,000 sq. yds. of streets; conc. and asph. with brk. or Medina blk. on grades. Abt. $110,000 available. Hopkins & Fields, City Engrs.

N. Y., Mohawk—Village Bd. having plans prepared for paving Marshall Ave., Orchard, Michigan, Washington and Warren Sts. Cost betw. $50,000 and $60,000. E. M. Evans, Herkimer Engr.

N. C., Spencer—Town considering plans for bldg. asphalt streets over principal thoroughfares here; 14,095 lin. ft., 25 ft. wide; together with necessary stone curb and cement gutters. Est. total cost $168,676.

O., Lima—City will pave following sts. if no objections are filed by property owners: West St.—Wayne to Penn. R. R.; Findlay Rd.—Jackson to Jefferson; Holme St.—St. Johns to Reese Aves.; Dingledine Ave.—Madison to Harrison; Jameson Ave. —Hazel to Harrison and Holmes St.—St. Johns to Reese. Petition being circulated for resurfacing of section of Main St. betw. so. side of public square and Ottawa river, practically ready to be presented to Council. Abt. 75 per cent of owners have signed.

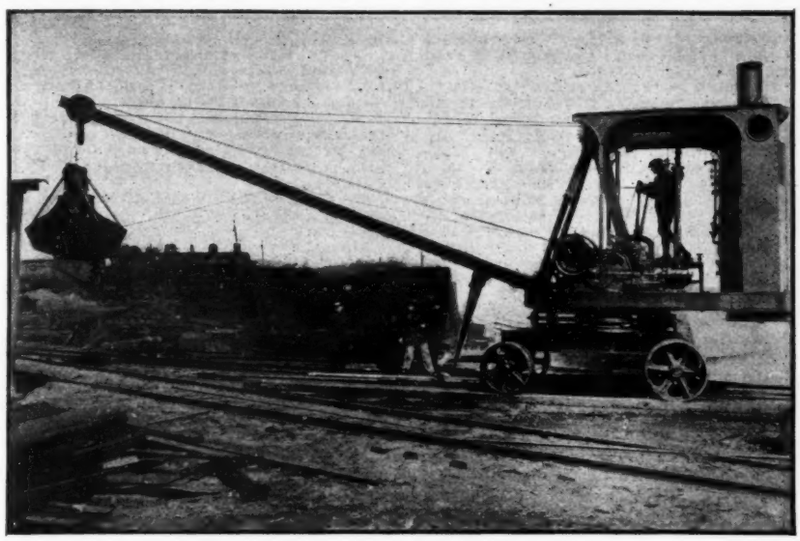
Okla., Ada—Final plans being prepared for paving and bids will soon be received. Paving districts being formed and it is estimated at least $1,250,000 will be expended on paving during this year. Johnson & Benham, Cons. Engrs. Kans. City, designing and supervising all city work.

Okla., Madill—As soon as city has awarded water works contracts, the street paving program will be taken up and pushed to completion. Bids will be received in July. Est. cost $500,000. Johnson & Benham, Cons. Engrs. Kans. City, Mo.

Okla., Sallisaw—V. V. Long & Co., Cons. Engrs., 1300 Colcord Bldg., Okla. City, Okla. have been selected to prepare plans for paving streets in business section. Est. cost $100,000.

Ore., Albany—Program for paved market rds. in Linn Co. will be inaugurated by County Court. First rd. extends from Scio to Green's brdg., which crosses No. Stantiam River; boundary line betw. Linn and Marion Cos. Marion Co. plans to pave this year from Green's brdg. to Jefferson. Court; also plans to pave road from Albany to Lebanon; also one from Brownsville to connect with Pacific Hwy. at Halsey.

Ore., Newberg—If plans of City Council



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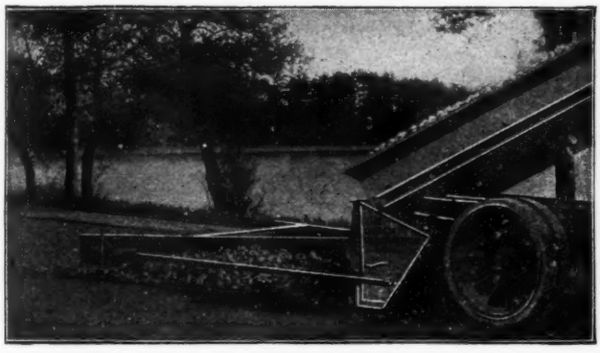

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carry, extensive street paving project will be undertaken this year to cost approx. $280,000. Plans and specfs. prepared by J. A. Garrow, Constr. Engr. Portland, and accepted by Council.

Ore., Pendleton—Bids will soon be asked for 15-mi. stretch betw. Pendleton and Pilot Rock; grading and graveling. Another 30-mile proj. will be let but Hwy. Comn. will have charge of receiving bids. County has appropriated $185,000 and state aid is expected. R. E. Phelps, Road Master.

S. C., Anderson—Gluck Mills contemplate paving streets and installing water works; $75,000. Equinox Mills considering expenditure of similar amount for paving and water works.

S. C., Newberry—$100,000 bonds voted here for paving streets. Eugene S. Blease, Mayor.

S. D., Canton—Lincoln County plans to construct roads costing $127,000 this summer. E. A. Jones, Co. Aud. Funds available.

Tex., Center—Plans being prepared for grading, surfacing and draining 10.9 miles Hwy. No. 9—Shelbyville to San Augustine Co., 16 ft. wide, involving 72 acres clearg. & grubbg., 59,400 cu. yds. earth excav., 26 cu. yds. conc. etc. About $110,833. Shelby County, T. H. Dillon, Engr. Center.

Tex., Childress—Childress Co. Commrs. contemplate grading, draining and surfacing with sand-clay 10.15 mi. Highway No. 4. Hess & Skinner, Engrs. Southwestern Life Bldg. Dallas.

Tex., Texarkana—City considering paving Hazel, Pine, Wood, Olive and other streets. Est. cost $600,000.

Vt. Bennington—Village having plans prepared and will soon receive bids for sewers. H. E. Breed, Village Engr.

Va.-Tenn., Bristol—Bristol-Tenn. Commrs. passed Impvt. Dist. Ord. calling for expendt. of betw. $175,000 to $180,000. Est. yardage is approx. 38,000 yds.

Wn., Bellingham—City considering paving of Cornwell street from Champion to North street. Est. Cost $80,000.

Wn., Olympia—Board of County Commrs. has approved County Engr. Fred Brown's report on Donahue road petition for paving county hwy. betw. Rochester and Grand Mound; 16-ft. cement thoroughfare for 8 miles. Engr's. prelim. est. on impvt. is $236,000.

Wash., Seattle—Lincoln County will call for bids in June for Donohue Rd. No. 3, which begins at point ½-mile east of Creston on Sunset Hwy. and extends 11 miles to Peach on the Columbia River. Est. cost of impvt. $110,000. Fed. Govt., thru State Hwy. Dept. will expend $15,000 and County $15,000 on Kellar Hill north of Wilbur. This is portion of State Rd. No. 4. Constr. Engr., J. L. Thayer, Lincoln Co.

Wash., Seattle — Snohomish County Engr. F. G. Tegtmeier reports that County is planning to complete 37 miles of highway constr. this season, segregated as follows: Paving, 10 miles; graveling, grading, culverting and draining, 27 miles. Payment for the work will be made out of following funds: Rd. & Brdg. fund, $163,449.54; state rd. fund, $75,000; F. A., $75,000; Bonds approved, $75,000; Rd. Dist. funds (3 districts), $186,752 and perm. hwy. $62,918—total $638,119.58.

Wn., Walla Walla—Walla Walla and Kitsap County Commrs. have formulated a tentative plan whereby, thru a combination of Donohue projects, & bonding, it will be possible to construct approx. 72 miles of rds. of permanent and semi-permanent construction. Roads generally decided upon include: beach rd.—Port Orchard to Waterman; Manchester, Colby & Harper, abt. 4 miles new constr. & balance improved; Chico Rd.— Charleston to Kitsap Lake—3 mi. improved; Oyster Bay & Finney Bay to connect with Bremerton & Charleston, 4 mi.; Kitsap Lake No. down to Chico Crk. to intersect. present Chico Rd. and eliminate hills, 1½ mi. new constr.; continue to Silverdale 3½ mi. perm. rd.; Silverdale east to Brownsville, 3 miles, part perm. and part improved; to Poulsbo, 7½ mi. permanent; to Kingston, 8 mi. perm.; to Hansville, Donohue project is considered 7½ miles; Brownsville to Manette, 4 mi. improved; Silverdale to Seaback, 6 mi. improved; Seabeck to Crosy, 4 mi. improved; Holly to top of Mellita hill, one mile improved. Road around beach eventually; Holly to Mason co. line & De Watto, 3 mi. improved; Ollala to Pierce Co. line, 1½ mi. improved; Burley to Pierce co. line, 1 mi. improved.

W. Va., Bellaire—Ord. passed for issuance of $150,000 for repaving program.

SEWERAGE AND SEWAGE TREATMENT

Ala., Montgomery—$50,000 bonds voted by City to construct san. and storm sewers; W. A. Gunter, Jr., Mayor.

Ariz., Yuma—S. F. Stanley, City Recorder, will soon receive bids for bldg. 13 mi. 4-20 inch vitr. san. sewer pipe, conc. pumphouse, sewerage pumping plant and 6 mi. 20 in. conc. outfall sewer pipe. Abt. $125,000. N. B. Conway, Yuma, Engr.

Ark., Little Rock—Plans for additional sewerage for Stuttgart have been presented to M. Z. Bair, Chf. San. Engr. for approval. Recommendations for suitable corrective measures for sewerage conditions at Pine Bluff have been forwarded by Mr. Bair, following survey of city by San. Engr.

Ark., Springdale—City voted $180,000 bonds for constr. of sewer and water systems. J. S. Ewalt, Mayor.

Cal., Alameda—$175,000 bonds voted to construct storm and sanitary sewerage system to serve all streets west of Grand Ave. C. E. Hickok, City Engr.

Cal., Los Angeles—Council has instituted proceedings for constr. of new main sewer in 7th and Broadway. Est. $400,000; 24-in. cement pipe sewer laid at depth of 24 ft. Sewer will extend from Maple Ave. in 7th St. to Broadway and No. in Broadway to Fourth, with branch in 6th St. Grand Ave. It is expected actual constr. work will start about middle of August. Ord. adopted to constr. cement pipe sewers in San Pedro St. Florence Ave., to 59th Pl. and 10 other streets in San Pedro; also Florence Ave., districts.

Conn., Bridgeport—City contemplates issuing $550,000 bonds for constr. of sewage disposal plant on east side. Engr. not yet selected.

Ill., Highland Park—No. Shore San. Dist. will proceed immediately with plans toward solution of sewerage purification problem. Est. cost of an aeration plant at Gillette Ave. is $125,000. Est. cost of impvt. $190,000, of which $60,000 will be expended this year.

Ind., Ft. Wayne—Bd. Pub. Wks. plans to construct main storm sewer 43, involving 8,015 ft. 12-48 inch pipe; cost $31,089; local san. sewer 316, 12,840 ft. 8-10 in. pipe, at $30,470. F. M. Randall, City Engr.

Ind., Mt. Vernon—Plans being made by City administration for construction of new sewerage system in western sect. of town.

Ind., Muncie—An expendt. of approx. $250,000 will be made by City soon in establishment of a south side sewer. Plans and specfs. drawn by City Engr. Work will start soon.

Iowa, Creston—Resolution drawn up to construct 10-in. san. sewer on portion of Taylor Street; 8-in. on Elm St.; 8-in. on Page, Maple, Pine Walnut, Park, Spruce and De Voe streets; also various alleys; 8-in. on Chestnut; 10-in. on sect. betw. Cherry & Poplar Sts., 27-in. storm sewer in alley betw. Division & Oak Sts. from Howard to Summit Sts. Carl Davenport, City Clk.

Iowa., Fairbank—In response to petition signed by a number of citizens here, State Bd. of Health has sent an engineer here to make san. survey of town. Lafayette Higgins, Engr.

Ia., Milford—Town Council has contracted with R. A. Furman of Spirit Lake to prepare plans and specfs. for storm sewers in different sections of town.

Ky., Louisville—$1,000,000 voted here for bldg. sewers on various streets.

Minn., Minneapolis—Bd. of Ests. & Taxation, City Comptroller and Sewer Dept. are speeding plans to begin work on trunk sewer on 31st Ave. n. e. from Main to University Ave., to reach 9th Ward. $150,000 bonds, issued for impvt., have been sold. C. Illstrup, Sewer Engr.

Mont., Winifred—City considering constr. of sewerage and water wks. systems. Abt. $90,000. A. Refer, Lewistown, Engr.

Neb., Tekamah—Work on sewerage system will begin next month according to statement made by Mayor Lukens. Work will be pushed as rapidly as possible. Est. cost of impvt. $85,000.

N. J., Hoboken—City Commission plans to build sewerage system and construct sewers in Paterson Ave.—Ferry to Marshall Sts.; also Clinton St.—12th to 15th Sts. Abt. $1,000,000. J. O. Whittemore, City Engr.

N. J., Jersey City—City plans to construct sewerage system betw. Grant and Fulton Aves. Cost will exceed $100,000. F. A. Dolan, Clk.

N. Y., Binghampton—$100,000 authorized by Council and Bd. of Est. for use of City Engr., W. Earl Weller, in preparing program of municipal impvts. is now available and Mr. Weller will undertake work of preparing revised plans for sewage disp. system at once.

N. Y., Utica—Common Council plans to construct storm water and sanitary sewerage systems in 13th Ward. About $125,000. J. Kemper, City Engr.

N. C., Smithfield—Town is offering $50,000 bonds for sale for purpose of constructing extension to present sewerage system and installing water pumping plant. W. L. Fu'ler, Clk.

N C., Sylva—City Comn. considering installing sewer and water systems; $90,000. J. B. McCreary Co., Engrs. Atlanta, Ga.

O., Akron—Improvements for 107,615 ft. of sewers, estimated at $1,565,390, will be started this year by Service Dept.

O., Canton—Recommendation for constr. of trunk sewer in valley of west branch of Nimishillen creek betw. N. Canton and Canton, made in report of Sewer Comn, at meeting of City Council.

O., Cleveland—City plans to build vitr. pipe sewers in E. 124th St., from Mount Overlook Ave. to Fairmount Rd.; E. 126th St.,—Mt. Overlook Ave. to Britton Dr.; E. 127th St.—Woodland Ave. to Fairmount Rd. Britton Dr. and Mt. Overlook Ave., from E. 127th to E. 12th sts.

Okla., Bixby—Town will construct water works and sewers; $15,000 and $28,000 respectively. R. O. McPeek, City Clk. Hughes Engrg. Co. 310-11 Bank of Com., Tulsa, Engrs.

O., Middletown—Legislation to issue $50,000 of the $100,000 sewer bonds authorized by voters to extend Bull Run sewer to east corp. line, begun by City Comn. Sewer will cost approx. $80,000 and will bring total to be expended for sewers, within next few months, to $123,000.

Tex., Arlington—$25,000 bonds voted to build extensions to sewerage systems in various streets. J. I. Carter, Secy.

Tex., Palacios—Palacios Sewer Company will soon ask bids for sewer mains and bldg. sewerage disposal plant. Abt. $35,000. J. W. Sartwell, Mayor.

Va., Coeburn—City will install sewer and water system; $40,000 to $50,000.

Va., Norfolk—City contemplates improving sewer system and installing storm drainage system; $22,000. W. H. Taylor, 3rd. Direct. of Pub. Wks.

Wis, Ashland—Ord. passed by City Council authorizing bonds amounting to $10,000 for constr. of storm and surface sewer on Vaughn Ave.

Wis., Cedarburg—Plans being prepared for installing water and sewer mains in various streets. $150,000 bonds voted. W. B. Kirchoffer, 31 Vroman Blk., Madison, Wis., Engr.

Wis., Kenosha—Allen Sons. No. Main St., having plans prepared for bldg. rein. conc. sewage disposal plant. About $50,000. Vaughn and Meyer, Security Bldg., Milwaukee, Engrs.

Wis., Waterloo—City having plans prepared for laying 5 miles vitr. sewer pipe in various streets. About $50,000. Parsons and Orbert, 627 M & M Bldg., Milwaukee, Engrs.

Wis., West Allis—According to City Atty., Jos. E. Tierney, Council will take immediate action in regard to enlarging West End septic tank.

WATER SUPPLY AND PURIFICATION

Ala., Montgomery—$150,000 bonds voted for improving and extending water works; $150,000 bonds voted. A. Gunter, Jr. Mayor.

Ariz., Somerton—$65,000 water and sewer bonds, recently voted, has been accepted by bond firm and money will soon be available.

Ark., Blytheville—Consumers Water Company must install 2 new pumps, one steam and one electric. Council has requested extension of water mains from Division street west to W. Blytheville which will cost abt. $3,000. Under franchise Company must make impvt. Extension of mains into Barron & Lilly addn. also ordered. $3,000.

Ark., Springdale—$180,000 bonds voted for construction of water and sewer systems. J. S. Ewalt, Mayor.

Cal., Alameda—Phillip E. Harroun, Cons. Engr., employed by Water Comn., of Eastbay Cities of Oakland, Berkeley, Alameda and Richmond, recommends the Elk River as source of water supply for these cities. Cost of completing initial developments to capy. of 250,000,000 gals. daily would cost $66,739,000 with deduction of $8,250,000 for power development.

Cal., Hayward—City expects to purchase water plant and is having plans made for

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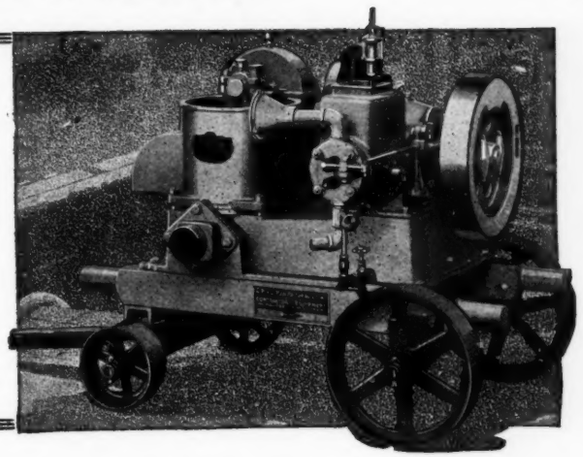


impvts. Est. cost $100,000. M. B. Templeton. City Clk.

Cal., Paradise—$140,000 bonds voted for constructing 13,000 ft. 36-in. pipe line, complete auxiliary reservoir system and distributing system. L. M. Edwards, Engr.

Cal., Quincy—$35,000 is to be expended by Calif. Fruit Growers' Exchange for constr. of water system at Davies Mill this year.

Cal., San Francisco—Constr. of hydro-electric generating plant on Pit River or its tributaries, with necessary transmission lines, authorized by State R. R. Comn. Total cost $3,180,000.

Can., Brandon, Man.—Council has decided to purchase chlorinator for water works plant and will engage W. M. Scott, Cons. Engr., Winnipeg, to make survey of distribution system. Council will also consider installation of electric system to operate water works plant.

Can., Buckingham, Ont.—Town plans to alter and extend water works; also install new cast iron distribution mains, hydrants, etc. About $75,000. Engr. not selected.

Can., Hamilton, Ont.—By-law passed by City Council to issue debentures to amt. of $58,300 for extension and impvt. of water works; also $160,000 for extensions and impvts. to Beach pumping station. S. H. Kent, Clk.

Can., London, Ont.—City Council granted permission to pass by-law to borrow $100,000 for storm sewers and $85,000 for extension of water works system. H. A. Brazier, City Engr.

Can., New Toronto, Ont.—Town considering enlarging water works system by addn. of new electric pumps and 4,100 ft. 16-in. feeder main. About $35,000. E. A. James Co., Ltd., 36 Toronto St., Toronto, Engrs.

Can., Port Credit, Ont.—Village having estimates prepared for water works system. Work will include brk. pump house, pumps, mechanical filters, chlorination, elevated tank, 1,200 ft. steel intake pipe and 20,000 ft. cast iron water mains. Abt. $88,-000, E. A. James Co., Ltd., 36 Toronto St., Toronto, Engrs.

Can., Port Colborne, Ont.—Plans being prepared for water works here. R. O. Wynne-Roberts, Engrs., 40 Jarvis Street, Toronto.

Can., Port Dalhousie, Ont.—Prof. R. W. Angus, Univ. of Toronto, is designing water distribution sys. for this municipality. There will be 3 crossings under canal; water to be purchased from St. Catherines.

Can., Regina, Sask.—City Council has decided to add to program of capital expendts. for this year's constr., approx. $108,000 for extensions of water and sewer mains in different sects. of city. Geo. Beach, City Clk.

Colo., Kersey—$40,000 bonds voted for constr. of water works system.

Colo. Nunn—$30,000 bonds voted for constr. of water works system here.

Fla., Tampa—City plans to issue $280,-000 bonds for impvt. of water works and erection of power plant, etc.

Fla., Tallahassee—City may install water, gas and electricity; $175,000. J. G. Greer, Mgr.

Ida., Weiser—Test wells being drilled as basis for water system to include 5 miles of pipe and constr. of reservoir.

Ill., Freeport—Water Company contemplates replacement of old pump with high-lift turbine, centrif. unit of 4,000,000 gals. capy; also deepening of an open, cinder-filled, circular well to water-bearing stratum and installing therein a 3 or 4,000,000 gal. centrif. pump, motor-driven and low-lift. O. T. Smith, Supt. Freeport Water Co.

Ind., Anderson—City considering appropriation of $350,000 for various impvts. Included is $50,000 for water plant.

Ia., Council Bluffs—City considering water works improvements. Additional settling basins. $150,000; also approx. 15 miles extens. to mains; $150,000. Will require bond issue. O. Hochman, City Clk.

Kans., Arkansas City—Plans and Spefs., for $135,000 worth of impvts. for Ark. City water works system, approved by Court of Industrial Relations.

Kans., Topeka—Plans prepared by W. S. Hoad, Cons. Engr. Ann Arbor, submitted to W. Stanfield, City Water Commr. providing for an adequate filter plant for city.

Ky., Newport—St. Joseph's Orphanage plans to construct reservoir, 1,000,000-gal. capy.; electrical centrif. pumps. steel tank of 60,400-gal. capy. on 100 ft. columns, distributing pipe system. About $20,000. G. Hornung, 512 Fairfield Ave., Bellevue, Engr.

La., Iota—City will construct water works and electric lighting system. Will receive bids about July 1st. Merrill Bernard, Crowley, La., Engr.

La., Minden—$180,000 bonds voted for City for impvt. of water works; install sewer system; purchase and improve electric light plant. Geo. S. Carroll, Mayor.

Mich., Bay City — Frazier-Elms-Sheal Co., Cons. Engrs., Cleveland, Ohio, authorized to proceed with preparation of plans for getting work under way with least possible delay, for improved water supply.

Mich., Farmington—Village will install electrically-driven auxiliary pumping unit and construct additional mains. Est. cost $25,000. R. A. Murdock, Engr., 603 Free Press Bldg., Detroit.

Mich., Marysville—Village having tentative plans and estimates prepared for bldg. semi-permanent water supply system consisting of pumping station with 1,000 ft. submerged intake pipe into St. Clair River, filtration plant and distributing main from river to Michigan Ave., involving 4,000 ft. 16-in. cast iron pipe. Abt. $200,000. R. Gordon, Marysville, Engr.

Minn., Cambridge—Druar & Smith, Globe Bldg., St. Paul, preparing plans for water works. Erick Lindahl, Vil. Clk. Est. cost of impvt., $35,000.

Minn., Hector—Cons. Engr. L. P. Wolff, 1,000 Guardian Life Bldg., St. Paul making prelim. survey for water works system, to include tower and tank. A. B. Dahlgren, City Clerk.

Minn., New Munich—Plans soon completed for tower and tank. Approx. cost $75,000. J. P. Benoklen, City Clk.

Miss., Clarksdale—City Commrs. contemplate improving water and light systems and streets. $500,000 bonds voted.

N. J., Metuchen—Town Engr. Mr. Kreiner, requested to lay out map for complete water distribution system. Laying of 24-in. main suggested at meeting of Citizens' Advisory Comm. Wm. F. Davis, Chrmn.

N. M., Deming—$100,000 bonds voted to purchase and improve water works system here.

N. Y., Carthage—Bd. Water Commrs. plans to construct 1,600,000-gal. steel water supply tank. Abt. $50,000. I. W. DeCant, Pres.

N. Y., Chateaugay—**High Falls Pulp & Paper Co.**, Paper Mill Road, plans to construct concrete dam on Lower Chateaugay Lake. Cost betw. $150,000 and $200,000.

N. Y., Rensselaer—Common Council plans to install water supply system (3,000,000 gal. daily capy.) Abt. $500,000.

N. Y., Rome—Water & Sewer Board has had plans prepared for bldg. 350- h. p. hydro-electric plant on Mohawk River. C. W. Knight, Engr, 101 W. Liberty St.

N. D., Bismarck—Plans for constr. of water system complete with an up-to-date filt. plant that will furnish 2,225,000-gals. water per day, presented to City Comn. It is est. the plant will cost $500,000. Plans prepared by City Engr. T. R. Atkinson.

O., Covington—Installation of filter plant demanded by Public Bd. of Health. Condemned quality of water supply. For detailed information address Chrmn. of Bd. of Commrs.

O., Eaton—Water Works system is to be equipped with filtration plant. Est. cost $27,500.

O., Grafton—Village voted in favor of issuing $40,000 bonds for water works and sewers.

O., Lakeview—Plans being prepared for bldg. and equipping pumping station, drilling deep well and laying service mains. Est. cost betw. $90,000 and $100,000. Jennings & Lawrence, Hartman Bldg., Columbus, Engrs.

O., Maumee—Council voted to have engineer's ests. and plans submitted for water plant which would be large enough to supply canal water to industries of town.

O., Niles—Incomplete returns on bond issue for $150,000 each for water works impvts. and school impvts., indicate both will carry by a two to one vote.

O., Warren—Plans for improved water supply sys. being prepared by Alex. Potter, New York City, Cons. Engr.

O., Wooster—$60,000 voted here for new water tanks.

Okla., Duncan—Plans being prepared for improving water works system. Abt. $38,-000. V. V. Long & Co., 1300 Colcord Bldg., Okla. City, Engrs.

Okla., Elk City—City will install additional water mains; $100,000. H. G. Olmstead & Co., Oil Exch. Bldg., Okla. City, Engrs.

Okla., El Reno—$400,000 bonds voted for impvt. of water works. Will erect a 2,000,-000-gal. capy. reservoir, etc. Ethel Dowell, Clk. Burns & McDonnell, Engrs., Interstate Bldg., Kans. City, Mo.

Okla., Erick—City having plans prepared for improving water wks. system. About $35,000. H. G. Olmstead & Co., Oil Exch. Bldg., Okla., Engrs.

Okla., Miami—$420,000 bonds recently authorized at election, have been sent to Okla. City to be approved by Atty. General. Funds will be used to extend water works and light system; also install sewage disposal plant.

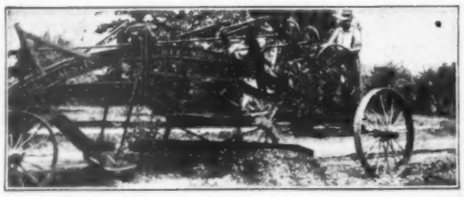
Okla., Paden—Plans being prepared by H. G. Olmstead & Co., Oil Exch. Bldg. Okla., Engrs. for impvt. of water wks. sys. including 4 mi. pipe line, pumping station, tower and tank. with 65,000-gal. capy. Est. cost about $65,000.

Okla., Pawnee—$100,000 bonds voted to improve water works system and electric light plant. Engr. not yet selected.

Okla., Pryor Creek—$35,000 bonds voted for water works extension. Plans ready in near future. V. V. Long & Co. Engrs. Okla. City.

Okla., Red Fork—Plans being prepared for improving water works system. About $30,000. H. G. Olmstead & Co., Oil Exch. Bldg., Okla. Engrs.

Okla., Shawnee—City will improve water works; install filtration plant; $220,000.



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The Austin Attached Scarifier operated and controlled by the roller man on an Austin Steam or Motor Roller, 10-ton or larger.

Western Wheeled Scrapers, Grading Plows, Rooters and Drag Scrapers are known nationally and internationally as the best.

The Austin and Western Elevating Graders to load material into wagons or to discharge on road shoulder or ditch.

Are You *Gaining* or *Losing* on the Sub-Grade?

Early in the job come the problems of road bed excavation. How to do it best? How to do it at a low cost figure?

These questions always come up on road construction and improving jobs. But their answers are not always so simple—for conditions vary so much and a method used successfully on one job often will not work out well on the next one.

So it is a case first of properly sizing up the job—then choosing the method of sub-grade cutting best suited to the existing conditions.

Many contractors and road builders have discovered that right at this point the experience of others is of considerable value. For the methods used successfully on one job will work out in another piece of work just like it.

In sub-grade work there are five different methods found in the Austin-Western line of road building machinery.

Note the illustrations and descriptions of these five Austin-Western methods in sub-grade cutting. Send for our details describing the entire line.

The Austin-Western Road Machinery Co.

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